SOVIET ORBIT* CAPABILITIES AND INTENTIONS FOR ELECTROMAGNETIC WARFARE (Below 30Mcs.)

EIC-R-12

FOREWORD

Electromagnetic warfare is the contest through preclusive use, jamming, interference and related measures for the control of all or parts of the radio spectrum or the denial of use by others. This report deals only with the so-called long-range portion of the spectrum (below 30,000 kilocycles) in so far as the direct conduct of warfare is concerned. The subject is much broader than the mere jamming of mass aural channels of radiobroadcasting. It envelopes the whole gamut of uses to which radio can be put in the spectrum portion considered. This assessment is intended to give some description of the present Soviet Orbit rapid communications profile, the manner in which these resources are employed, their purpose and use, and a measure of their essentiality. From this point of departure, trends, capabilities, vulnerabilities, and intentions with respect to enlargement of electromagnetic warfare are developed basically from the standpoint of strategic and economic service, under cold war conditions during the next two years.

* USSR, Albania, East Austria, Bulgaria, Czechoslovakia China, East Germany, Hungary, Poland, and Rumania

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Summary

The radio medium is a worldwide natural resource. It is extensively exploited by the Soviet Orbit. Wire as well as radio conjoin in providing the Orbit with a rapid communications profile of mammouth proportions. Though complex, the parts are generally integrated for maximum service to the state. There is heavy dependence on radio. Wire line facilities are inadequate in large areas of the Orbit east of the Urals. Radio is the only rapid medialfor communications, long-range navigation, and guided missile control services involving mobile units. Its radio resources facilitate and accelerate the exercise of the sum total activities of the state in all its ramifications, political, economic, social, propagandistic, and military. Jamming today is among its uses.

The most critical area from the vista of rapid communications inadequacies is the strategic Arctic area. Air routes between northern Siberia and the United States are generally shorter through the Arctic region by great circle navigation. But it is in the Siberian area where Orbit wire facilities are sparsest, thus aggravating the dependence on the radio medium. Further, radio propagation in this area (North Auroral Zone) is somewhat unstable, hence unreliable. Moreover, rapid physical transport to back up the more rapid communications media are also sparse in this area. These factors together connive to render the area critical.

The equipment necessary for communications and jamming operations can be manufactured by the important Orbit electronics industry. For essential and military electronics requirements there exists in the Soviet area of control sufficient capacity due to the rapid growth during the last few years. The production of decimeter radio relay equipment has grown from nothing in 1948 to an estimated 1500 sets in 1952. Production facilities are adequate to produce electronics required for a reasonable electromagnetic warfare program. The effect on other Soviet electronics programs will depend on the scope of their undertakings. Receiving and transmittor tube production capacity exists for feasiable programs. Transmitters can be manufactured in reasonable numbers. If larger numbers of transmitters are required, electronic production facilities can be diverted if sufficient priority is given to expand electromagnetic warfare program by the Kremlin. Equipment production will therefore not be a major factor in influencing electrmagnetic warfare.

Rapid electric communications systems require electric power as the source of energy. Although the percentage consumed by communications of the total available to the Orbit is minute, a continuing supply of electrical energy is essential to proper operation of electrical rapid communications. But the inadequacies of power distribution over large areas east of the Urals impose logistic and generating problems that could become vexing under sudden heavy demand conditions.

The availability of communication manpower is not abundant, but adequate, and capable of being increased over a period of six months or so. In the field of techniques, procedures, and technologies, Soviet competence seems to be as far advanced as that of the West in some areas. In others it is less creative and more imitative. But imitation itself cannot close the gap between conception of an idea and application. Exploitation particularly of East German, Czechoslovakian and Hungarian competence has made modern contributions to Soviet know-how.

The Soviet Orbit does not enjoy fully standardization of communications equipment and procedures. Incompatibilities should result in difficulties in achieving maximum integration, maintenance efficiency, and maximum flexibility of operations.

Post World War II trends have been marked by restoration activities, followed, about 1949, by increases in the capacity of existing plant, extention of plant to virgin territory, and the application of new world techniques and technologies created during and since the war. Apparently several new significant land lines and at least one significant submarine cable have been installed in or into the strategic Arctic area. Of pertinence here is rather huge development of the wire-diffusion systems for the wire line distribution of mass aural broadcasting programs. The radio transmission base has been steadily increasing in terms of number of transmitters, power, uses, and service area. Production of microwave radio equipment suggests that some systems are already in operation. The jamming system has continued to expand since its inception in the post World War II era. Over the next two years the Soviets will push forward to greater heights the developments they commenced when restoration was about complete in 1949.

The Soviet Orbit possesses at least some 9,600 significant radio transmitters. By the application of numerous operational methods the Orbit could appreciably enlarge its electromagnetic warfare capabilities. But the strategic cost of utilizing these capabilities is thought to vary exponentially with the extent of their utilization. Rapid communications are fundamentally means for accelerating human action and accelerated human action in turn imposes demands for additional accelerating means. The strategic cost of maximum utilization of present capabilities over the next two years are considered to be almost intolerable. Since one of the prime objectives of the Kremlin is given as the rapid expansion of the strategic power of the Soviet Orbit at an accelerating rate, it would seem that the Orbit would need to develop more and more communications resources for legitimate services rather than to consider any significant curtailment therein. Where there is a choice of media the Kremlin can favor wire over radio, or physical media over both. There is grave question, however, whether the Orbit, at least in those huge areas where rapid communications resources are relatively undeveloped, could afford the luxury of doing anything itself that would diminish or tend to diminish, for the next two years at least, the rate at which it seeks to accelerate the growth of strategic power. Nor does it seem likely, for the same reasons, that the Orbit would cherish the potential retardational effects of retaliatory jamming upon the rate. Maximum utilization of electromagnetic warfare capability could impair the politically cohesive and control benefits of domestic mass aural radiobroadcasting, the agitative and propagandistic potency of international mass aural and press radiobroadcasting, the efficiency of economic performance, the cultural and social satisfactions of the people derived through and from rapid communications services, and the strategic and tactical contributions of radio services for the exercise of military command the effective deployment and use of military weapons.

The Soviet Orbit could markedly increase its electromagnetic warfare capability over the next two years. The amount of increase would directly depend upon Kremlin intentions with respect to jamming. If future jamming potential dominates production planning and rapid communications systematization in such wise as to diminish dependence on radio below 30,000 kilocycles, the increment in capability could be large. But even without any Kremlin intentions to enlarge jamming capabilities as such, the growth of radio facilities to support all other plans and intentions would automatically yield an increase in capability.

Vulnerability, the susceptibility of Orbit to disruptions in the exercise of the sum total activities of the state in all its ramifications, is assessed by measurement of the strategic essentiality of Soviet Orbit radio services for that purpose. Where there is no essentiality there is no vulnerability. Only strategic essentialities are considered. Radio communications channels are classified according to strategic essentiality of the service they contribute. Command channels are required for the exercise of supreme authority and control. Hence the demand for radio as a rapid media for some of these channels is heavy. Hence the vulnerability of Soviet command channels is rather high in all areasexcept possibly in the European Orbit. Intelligence channels, of which nothing is known, are mentioned because of their high strategic importance. Operational channels, which are required for the optimum deployment and employment of strategic power where time is precious and dependability of service vital, are of two types from the standpoint of vulnerability. The non-mobile operational channels are not necessarily dependent upon radio and the mobile operational channels do depend upon radio. All segments of the Orbit hierarchy and subordinate echelons (political, economic, air, sea, and land) require the service of such channels. The vulnerability of non-mobile communication channels is high but not so high as for command channels. The vulnerability of mobile channels depends upon the number, characteristics, and types of missions of the units involved and could approach the strategic importance of command channels, as in the chase of a large flight of long-range bombers armed with atomic bombs on an attack mission. The vulnerability of Orbit mobile radionavigational and radio control (for guided missiles) services is considered generally high for combat usage, but for non-combat usage much lower. Support channels are those channels required for the exercise of Orbit housekeeping functions. They are the most numerous class of channels. The vulnerability of support channels is generally less than that for the otherthree classes. They are less important and the service they perform can generally tolerate some delay or can be dispensed with. On the whole the vulnerability of this class of channel would probably rise exponentially with the elapse of time during which the service they perform was unavailable.

Retaliation implies the existence of enlarged Soviet electromagnetic warfare. Soviet planning for an enlargement of electromagnetic warfare would probably include plans to minimize the effects of retaliation. Planning would also take into account the exposure of Soviet radio channels to its own jamming.

The probable effects of retaliation may be of three kinds: 1) end effects upon the sum total activities of the Orbit; 2) the effects upon the operational utilization of the rapid communication resource; and 3) the diversion of resources. The effects upon the activities of the Orbit would, assuming that retaliation was effective, result in a slowdown in these activities and if continued would eventually result in losses ineffective strength of the Orbit. The slow down would begin at a low level, probably rise rapidly, and begin to recede soon after readjustments could be made. Quantitative analysis of the effects of retaliation, if possible at all, would be exhaustingly laborious. The operational utilization of rapid communications would be affected by retaliation by a realignment of the traffic loads carried by the various rapid media, by the diversion of less essential traffic to less-than-rapid physical means, and by the suspension of non-essential traffic. Retaliation, if effective, would be expected to induce some diversion of resources. The levels of diversion would hinge on the essentiality of the class of channels. The diversion of resources for command channels could be considerable and involve hurried construction of new facilities regardless of men and material costs. To a lesser degree diversion of resources might take place for contruction of new facilities to handle the less essential channels.

The Soviet Orbit cold war electromagnetic warfare intentions may be assessed by analysis of performance, implications, and planning. As to performance, the Orbit has been building what appears to be a jamming systems of which the magnitude and effectiveness appears to be increasing. For the most part, the jamming has been directed against "hostile" radio signals (mostly radiobroadcasting) entering the "sovereign" domain of the Orbit. It would be, however, hazardous to our communication security to conclude that jamming of radiobroadcasting represents total Soviet intentions. Possible implications of the jamming performance today are that it helps to achieve more complete East-West communication discontinuity, and it serves as a proving and exercising ground for the development of a broader electromagnetic warfare resource. With the US removed in distance from its European and Pacific allies it is heavily dependent on radio for rapid communications. The Soviets must be aware of this situation and have most likely included it in their electromagnetic warfare plans.

It seems clear that, under cold war conditions, the Soviets intend to continue to work toward minimization of the strategic essentiality of Orbit radio services. This can be done by reducing their present heavy dependence on the radio medium below 30,000 kilocycles. Contruction of non-radio rapid communications facilities will probable continue to be of prime importance but in the vast areas east of the Urals it is unlikely that the dependence on radio can be eliminated within the next two years. In the case of the mobile services radio is essential and of increasing importance. The Soviets are unlikely to ignore these factors in their planning for an enlargement of electromagnetic warfare.

There is no evidence at hand to indicate that the Soviet have, in fact, invoked thus far any of its electromagnetic warfare capabilities. The current jamming effort against foreign radiobroadcasting can be characterized as a legal contest with psychological warfare implications. Electromagnetic warfare would, quite possibly, be invoked on a localized basis so as not to reveal the Kremlin's full hand of tricks.

The Soviet Orbit possesses, in being, a mammouth rapid communications resource. Included in it are active and potential jamming facilities which could be improved and expanded. The rapid communications system is being improved and expanded, but more than two years will be required to minimize the essentiality of its radio services. In the meantime its vulnerability in terms of the strategic essentiality of its radio services is high. The full commitment of this capability for electromagnetic warfare in the face of its high vulnerability would be intolerable for several years to come. Localized employment under cold war conditions of electromagnetic warfare in such a manner as to not bring on retaliation would seem to be the pattern which could be followed with the least disruption to the Soviet Orbit.

The incidence of a hot war would invoke on the part of the Soviet Orbit as full an employment of its electromagnetic warfare capability as its war time legitimate strategic essential radio needs would permit.

INTRODUCTION

The radio medium is a worldwide, natural resource.* It is a harnessable means of transport, at the speed of 186,000 miles per second, for the conveyance of ideas, information, and remote control signals. It exists everywhere. Hence it is not subject to world monopoly by any country or group of countries. Today it is used by all civilized countries. The radio medium not only competes successfully with the only other rapid medium for communication purposes, the wire line, but has far surpassed the wire line medium in its versatility of use. Apart from its almost exclusive domain for specialized functions, such as radiolocation, radio-control, and radionavigation, the radio medium is the only available medium for rapid communication with andbetween mobile units (aircraft, ships, land vehicles) over appreciable distances. Its value as a medium of rapid, mass communication is excelled by no other.

One common unit of measurement of the radio medium is "frequency". The frequency range of the radio medium, known as the "radio spectrum", covers from 10 kilocycles to the order of 3,000,000,000 kilocycles. All frequencies do not traverse the radio medium equally well. Those above 30,000 kilocycles generally are useful for relatively short distances, or line-of-sight applications. Those below 30,000 kilocycles generally comprise the long-distance portion of the radio spectrum.**

Any strategic and economic dependence of the power nations of the world upon this relatively small, though precious, almost fully-occupied segment of the radio spectrum for numerous long-range services would cast this segment in a crucial role.

The key to any appraisal of Orbit electromagnetic warfare potential is the sum total of the active and reserve radio transmitters it can put on the air. This is so because any radio transmitter capable of radiating electromagnetic energy on frequencies below 30,000 kilocycles must be assumed to be a potential jammer, but much more needs to be known. This includes the location and characteristics of the transmitters; the strategic importance of the normal service(s) of those transmitters in the minds of the Kremlin; the availability of alternate means; the disruptive effect, if any, of Orbit jamming of Orbit strategically vital radio services; the disruptive effect, if any, of Western retaliatory jamming of Orbit strategically vital radio services; and the variations in effects including jamming intensity and duration, among others. The solid data upon which solid answers can be formulated are not available. However, sufficient fragmentary material is on hand to formulate estimates in measuring Orbit capabilities of enlarging electromagnetic warfare and of its cold war intentions in this field.

The time limit imposed for the preparation of this report required the use of unevaluated as well as evaluated material in order to achieve some semblance of scope and depth. For this reason the report should be considered somewhat impressionistic rather than completely factual and soundly conclusive.

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* Appendix A "The Radio Medium as a World Resource" develops in some detail the general nature, significance, and conditions of use of this resource.

** 30,000 kilocycles = 30 MCS

I. The Present Orbit Radio and Wire Communications Profile.

Introduction.

The present Orbit rapid communications profile is a complex in which both the radio and wire media are employed. In practice the employment of the radio medium is seldom wholly divorced from the wire medium. The inter-dependence that exists takes several forms. In some applications wire facilities complement the radio facilities. In others they are supplemental. They are sometimes alternate to each other. Wire lines are frequently used to provide control circuits for the operation of radio facilities. Wire facilities sometimes provide the only rapid means for the collection and distribution of communications received from or addressed to mobile units equipped with radio facilities. The wire medium does not possess the versatility of the radio medium. But modern technologies, some developed initially for application to radio, have permitted far-reaching increases in the capabilities of the wire as a conveyor of rapid electric communications of various kinds. In view of the foregoing the wire medium cannot be ignored in any discussion of radio service discontinuities.

Although operating on radio frequencies beyond the 30,000 kilocycle limit of this report, the highly pertinent micro-wave (decimeter) radio technology, developed practically since World War II, is germane to the Orbit communications profile in somewhat the same way as the wire line medium. The strategic and economic implications of this technology and its incipient application in the Orbit are telling. It possesses all of the advantages of radio below 30,000 kilocycles, except long-distance coverage without the intermediacy of relay stations. It possesses all of the advantages of wire. It offers high circuit capacity, almost unlimited spectrum space, almost complete communications security, low susceptibility to magnetic, atmospheric and other disturbing influences, low vulnerability to electromagnetic warfare, a high measure of recuperability, and, when mobilized a quick means in emergencies to replace or augment certain wire or radio facilities. Its essential disadvantage for long-distance communications is the necessity to provide relay stations about every 30 miles.

Radio below 30,000 kilocycles stands alone as the rapid medium for communication over appreciable distances with and between mobile units, to bridge quickly large bodies of water, and to span with rapidity large land areas not otherwise provided with rapid communications facilities.

This section describes the Orbit communications facilities and systems in being, along with perceivable trends in their development and use. The whole gamut of activities essential to exploit these communications resources fully to serve Kremlin strategy--their development, installation, protection, operation, maintenance, and expansion--require direct support of other resources. Those to be considered are manpower, productive, technical and technological resources.

A. The Facilities and Systems

1. The Soviet Union

General

The Soviet Union comprising over 8.5 million square miles employs radio in all modern recognized communications and operational services. For its internal basic communications needs, the Soviet Union employs radio more intensively and extensively than any other country in the World. It is used in parallel with wire lines to the same points. It is used to reach points beyond wire line terminals. Appendix B, a map, gives a picture of the distribution of the known main trunk line wire facilities (with a few such facilities in the northern European area unconfirmed). Also shown on the composite impressionistic map are all reported but partly unconfirmed radio stations assumed to contain from one up to say fifty or more radio transmitters. In a sense, it depicts the radio generation plant of the Union. The map shows that great expanses of central and northern Siberia and the Arctic appear to depend almost wholly upon radio for rapid communications services within these areas and with other areas of the Soviet Union. Polyarnyy, Murmansk, Iokanga, Vorkuta, Dudinka, Khonu and Nikittsy (unconfirmed), Vilyuysk, Ust'-Aldan, Krest-Khal'dzhay, and Ust'-Srednikam below it seem to be the only exceptions. 1/ 2/ 3/ With inadequacies in other forms of rapid surface transport in these vast areas, air transport can seemingly provide the only relatively fast alternative means of intelligence communication.** The apparent lack* of wire line facilities in these areas, except as pointed out above, does not prove lack of importance of either the wire line or the area. Recent reports indicate that wire lines are being extended northward usually towards and along rivers. Activities of strategic and economic importance are carried on there. These include shipping over the Arctic Ocean route, meteorological studies and observations, air transport, mining, lumbering, etc.

Strategically important observations may be made from this broad picture. Those areas of Siberia which apparently must depend upon radio for communications and functional services are for the most part closer by great circle route to the US than are all other portions of the Soviet Orbit domain, where, oddly enough, both radio and wire facilities are more prevalent. This means that any Soviet air operations to the US over these short-haul great circle routes must depend heavily, if not alone, upon radio for its strategic, command, tactical, operation, and intelligence communications and functional services. Since radio signals travel great circle routes between the points of transmission and reception, it also means that these vital Soviet radio facilities, from the standpoint of distance alone, are in the front-line position vis-a-vis the US and hence may be critical to electromagnetic warfare plans and strategies.

* The absence of data on the existence of wire line facilities to and along the whole Arctic front does not prove non-existence. The strategic importance of the area would seem to justify the need for both media. This need for wire is further accentuated by the anomalous radio propagational conditions existing in the vicinity of the Arctic (Auroral Zone). Suitable north-south routes for extending the wire line system into the Arctic, which might mitigate the evils of the permafrost problem, might be in and along the White Sea-Baltic Canal, in or along the long rivers, which generally run in a northerly direction, and the short land-river and sea routes to the East Siberia Sea.

** See Airlines Map - Appendix P.

a. Civil Facilities

(1) Basic System

The basic communication system (telephone, telegraph, telephoto) serving the general-purpose needs of the country comprises over three millions of kilometers of wire* in various forms. As of March 1951, the USSR was allegedly operating altogether over 1,490 radio stations in the Fixed Service (including Aeronautical Fixed Service). Some of these, however, may not operate into the basic system. According to international records these 1,490 Fixed Service radio stations had assigned to them over 11,900 frequencies below 27,500 kilocycles. Reportedly in 1951 the system handled 132 million interurban and international telephone conversations and 283.5 million domestic, international, and transit telegrams. During 1945, 1.5 billion words of telegraph traffic was said to have been handled by radio alone.

Appendix B is an impressionistic composite graphical presentation of all reported, and partly unconfirmed principal wire facilities and overall radio stations of the USSR. Probably all of the wire line facilities but only a portion of the radio facilities shown are direct components of the basic system. Many of these radio stations operate in whole or in part in other services to be described later.

Table 1 infra is a partial list of cities having extensive wire and/or radio basic communications facilities. They seem to fall into the category of main centers. They communicate with Moscow, the principal center, and with each other. They serve their own areas directly and through regional and rayon subcenters. The figures entered against each center give the number of radio frequency listings below 30,000 kilocycles entered in official international documents for that city. They do not necessarily reflect radio usage, radio dependence, the number of transmitters, or the number of stations. 4/ 5/ 6/

Table 1.

Partial List of Conjectural USSR Main Basic Wire and/or Radio Communications Centers with the Number of Listed Frequency Assignments(below 30,000 kilocycles)

Moscow	594	Sverdlovsk	76	Stalinbad	29
Irkutsk	239	Krasnoyarsk	68	Riga	21
Khabarovsk	199	Kharkov	64	Simferopol	18
Novosibirsk	145	Tiflis	64	Kazan'	12
Tashkent	124	Kiev	53	L'vov	12
Vladivostok	116	Komsomolsk-na-Amure	47	Saratov	7
Leningrad	100	Anadyr'	44	Kzaudzhikau (Ordzhonikidze	6
Yakutsk	99	Rostov-na-donu	43	Minsk	3
Alma-Ata	95	Ashkhabad	32		
Baku	84	Omsk	30		

Table 2 infra is a list of additional cities which may not be functioning as main centers but which show a relatively large number of listed frequency assignments. 7/

* Excluding wire lines devoted to wire-diffusion broadcasting.

Table 2. *

List of Additional USSR Cities Showing a

Relatively Large Number of Assigned Frequencies

Archangel	73	Chita	56	Astrakhan	39
Petropavlovsk (Kamchatskiy)	61	Odessa	43	Semipalatinsk	35
		Tobolsk	40	Aleksandrovsk (Sakhalinski)	33

The wire lines (Appendix B) like the railroad lines (Appendix L) provide service to the populous areas of the country which are shown in Appendix L. In spite of the wire coverage in these populous areas powerful radio stations are found in key cities. Additional powerful radio centers are found at important locations north of 60° latitude north. Sites of the more powerful, long-range radio stations are displayed in Appendix K Map 2.

In addition to these high frequency stations, there are very-low-frequency stations in the extreme far north for point-to-point communications. Appendix K Map 1.

Gateway cities for the handling of "open" international communications are listed in Table 3 infra. 8/

Table 3.

List of USSR Gateway Cities for the

Handling of "Open" International Communications

Ashkhabad	Leningrad	Tallin (Estonian SSR)
Batum	L'vov	Tashkent
Irkutsk	Moscow	Tiflis
Leninakan	Odessa	Vladivostok

Appendix C contains a list of the international facilities (International Telecommunications Circuits) operated from these gateway cities. Included are the points of communication, the method of communication, and the media employed. The use of the radio medium involves frequencies below 30,000 kilocycles. Included on page 1 of Appendix C are some detail statistics on these facilities for the whole Orbit.

The cities shown in Tables 1, 2, and 3, supra all of which employ both wire and radio with the exception of Petropavlovsk (Kamchatskiy), form the hard core foci of the basic domestic and international rapid communications system of the Soviet Union.

Though not properly considered part of the basic system, certain additional strategically important international radio facilities are listed in Appendix D. This is a partial list of "closed" or covert strategic and emergency communications channels provided by radio stations installed in Orbit embassies or legations in foreign countries. They are probably intended to communicate with Moscow and/or their home capitals. To safeguard these channels for vital use, it is likely that they are at present seldom used, if at all.

* It is a curious fact that Murmansk in the Arctic and Kuybeyshev (the alternate capital of the USSR during a portion of World War II) do not appear in either list. This omission suggests the possibility that the USSR may not have amended its international notification records to the International Telecommunications Union since the late 1930's or early 1940's.

(2) Aeronautical Systems

For rapid transport in a country many large areas of which are without modern highways, railroad lines, and inland waterways running in the right direction air transport looms important. This is particularly true of the Soviet Union east of the Urals and north of the general route of the Trans-Siberian railroad. Air transport east of the Urals is of great economic importance to the country. It supports the Northern Sea Route by providing year-round access to the rich mineral deposits and other natural resources in Siberia. It services the new hydro-electric and canal projects in this area. It assists in the maintenance of meteorological services which in turn serve the whole country, and in supporting scientific explorations in the arctic and desert areas. Air transport in this large area also serves political purposes by providing a rapid transport link between the Kremlin and the areas. Air transport is widely used for the distribution of newspapers and other party propaganda media. It carries mail and key personnel. The most recent development of some significance east of the Urals has been the extension of air service by three different routes to the Communist China capital of Peking. 9/ In part, the very absence of adequate rapid communications facilities in this area helps to stimulate the development of air transport there. The safe and efficient operation of air transport in this area in turn requires the provision of suitable aeronautical radio communication and radionavigation aids.

There are three kinds of aeronautical radio service: The aeronautical fixed service, the aeronautical mobile service, and the aeronautical radionavigation service.

Little is known about the wire facilities used by the USSR to serve its civil and military aeronautical operations. No doubt some wire lines are specially employed for these services. Appendix F spots some of the Soviet radio stations providing aeronautical mobile and/or radio navigational aid service. In 1949 it was thought that stations performing aeronautical fixed service were closely connected, even to the use of the same radio channel as that which the aeronautical station (land station used to communicate with aircraft) uses to communicate with aircraft. In 1949 there were thought to be over 300 radio stations associated with airlines and airfields, and this number has probably been increased considerably since that time. It is not known to what extent civil and military aviation communication is integrated. Appendix F also shows some of the radio transmitting stations offering radionavigation services to aircraft.

(3) Maritime Systems.

While the USSR was never a great maritime power, it did rank eleventh among maritime nations in 1939 for vessels of 1,000 gross registered tons and over. Heavy tonnage losses were suffered during World War II but Lend-Lease and other replenishments have since more than made up for those losses. She operates hundreds of vessels of 1,000 tons and over. Half of its merchant fleet is based in the Far East. In recent years the Soviet Government has put increasing stress on the need for augmenting the role of water transport in the national economy. Among others, the USSR operates water transport in the White Sea, Gulf of Finland, Black Sea, Caspian Sea, Sea of Okhotsk, the Baltic, over the Northern Sea Route. Some of the service is domestic coastal, and some deep sea ocean. Additionally the USSR operates fishing fleets and a considerable amount of inland transport is conducted over the numerous long rivers of the country. 11/

There are two kinds of maritime services: the maritime mobile service and the maritime radionavigation service.

Little is known about the wire facilities used by the Soviet Union in connection with its civil and naval maritime communications operations. Probably some wire line facilities are involved. Appendix F spots some of the radio transmitting stations providing these two kinds of service. In 1949 it was thought that 350 or more radio stations were involved with shipping (probably naval and mercantile). They appear to form two separate though closely integrated networks, one for river and the other for ocean transport. It is thought that stations at six or more important locations serve as focal points for all maritime traffic in their general vicinity and as interchange points for traffic with the basic communications network. The main station for communication with the Soviet fleet on the high seas is said to be located in Moscow.

Officially published Soviet Union statistics showed that, as of September 1951, the USSR was operating only 214 coast (communications) stations. All of these stations provide telegraph and most of them telephone service. The same source shows 768 ships, including naval, military, and ice-breakers, were equipped with radio. 12/

(4) The Land Mobile Radio System

Land mobile radio services comprise communications services between mobile radio stations and base radio stations and between two or more mobile radio stations. The Soviet Union operates many such services to facilitate government, industry, and particularly military operations. Mobile radio stations are installed in railroad engines and cars to expedite the operation and control of trains and to facilitate yard switching. Mobile radio stations are installed in motor vehicles to strengthen security and aid police control. Mobile radio stations installed in machine tractors are used to accelerate agriculture by assisting in the dispatching operations. Mobile radio stations are probably used in mining, manufacturing, and the larger construction operations. Though many of these applications use radio frequencies above 30,000 kilocycles, it is likely that some frequencies below 30,000 kilocycles are also employed.

Undoubtedly the Red Army is by far the greatest user of the land mobile radio service, even though it also uses wire lines in its operations. 13/

(5) Meteorological Radio System

Meteorological radio services include the transmission of special radio signals intended solely for meteorological including hydrological, observations and exploration, and for the transmission of meteorological bulletins and weather reports. These services probably support the economy, agriculture, science, air and water transport and other needs of the country. In 1949 it was thought that practically all of the larger radio stations gave some kind of meteorological service. Other stations, mainly small, had been established for reporting meteorological observations. In 1949 bulletins were reported to have been broadcast by radio from 21 locations. The Soviet Union maintains many radio stations on the land masses and islands along the Northern or Arctic Sea route from Murmansk to the Pacific Ocean. Many of the radio stations shown on the map in Appendix B conduct meteorological service of one kind or another. Originally many of these were to furnish long-range meteorological data from fixed locations to aid in scientific and military experimentation. Subsequently they were said to be used for general exploration and exploitation of the Arctic Sea and air routes. They apparently maintain communications with each other and with certain principal stations which intercommunicate with main radio stations of the basic network nearest to them. In 1949 there was evidence of about 200 stations in the Arctic regions (north of about latitude 52° north), and it was estimated that there were at least 200 more. 14/

(6) The Broadcasting System

For rapid collective communication the Soviet Union employs two basic kinds of broadcast service. One is the popular mass aural broadcasting service for the benefit of the general public. It provides domestic and international service in the low-, medium-, and high-frequency portions of the radio spectrum, all below 30,000 kilocycles. The other broadcast service is the more specialized and limited service generally employing forms of telegraphy, for both domestic and international reception for the benefit of more specific addressees. One known application of this technique is the press broadcast service. Other broadcast services are probably associated with the more strategic need of the state, such as broadcast intercept service for submarines and other vessels of the Red Navy and outpost or advance bases.

(a) The Mass Aural Broadcasting System.

The USSR operates an extensive mass aural broadcasting system providing for the internal or home service and the external or international service. The basic motivation behind the home service is the means for communist indoctrination and agitation and that behind the international service is Communist prppaganda. Because propagational parameters and language complexities are restrictive limitations many USSR broadcast transmissions are beamed to selected internal and external areas. Appendix E is a list of Soviet cities from which these transmissions emanate, along with the number of transmitters and the frequencies and powers employed. Page three of this appendix gives consolidated statistics on these radio transmission facilities. They show that the USSR employs at least 168 transmitters in at least 85 cities. The transmission power employed ranges from 1 kilowatt to 500 kilowatts. Of these 168, 42 operate in the bands below 500 kilocycles, 61 in the bands between 500 and 1,600 kilocycles, and 65 above 1,600 kilocycles. Of the total number, 3 low-frequency, 2 medium-frequency, and an estimated 22 high-frequency transmitters are in the Moscow area. The map in Appendix B symbolizes the location of these cities. Some of these transmitters undoubtedly operate as part-time jammers. 15/ 16/ 17/ The locations of broadcast transmitting stations are scattered over the country. They are densest in European Russia and thinnest over the north central and northeastern areas of the USSR.

The internal system comprises three levels of stations, the All Union stations in and around Moscow, the primary stations located in one or more cities of each of the republics, and the local stations. All three levels of stations originate programs. In addition the primary stations rebroadcast portions of the Moscow transmissions and the local stations rebroadcast portions of the primary station transmissions which include portions of the Moscow transmissions. This systematization gives Moscow a "command" channel down the echelon to localized points. A calculated estimate of the total number of domestic program radio medium transmission hours per day comes about 900 hours. The Soviet Union has claimed that some 76 languages are employed in this system, but monitorial observations reveal the use of only 26 including Russian. The unheard languages may be used on relatively low-powered transmitters of short range or over wire-diffusion networks. 18/

The wire line plays a strategic as well as a political and economic role in the Soviet mass aural broadcasting system. Wire lines are used to relay Moscow broadcast transmissions to distant city stations for retransmission. Another principal use of wire lines is for the distribution of broadcast programs to loudspeakers, rather than to individual radio receivers which obviously depend upon the radio medium. These wire lines for the most part seem to be independent and separate from the wire lines used for telephony and telegraphy. By wire connection to the transmitting studio, loudspeakers in the surrounding area are served. The wire link is also employed to transmit programs to more distant wire-diffusion exchanges. Other remote areas are served by wire-diffusion exchanges which pick up more distant programs by radio, amplify them, and distribute these signals to wired loudspeakers. In 1951 it was thought that the Soviet Union operated over 11,000 main wire diffusion exchanges serving over 6.8 million loudspeakers, and over 15,000 minor wire diffusion exchanges (post-war development) serving over 2 million loudspeakers. They are scattered over the country and obviously employ incalculable kilometers of two-wire lines. 19/

This wire mesh has important implications for electromagnetic warfare. It is available for civil defense warning notices, as many of the connected loudspeakers are located in public squares and key locations. It is available for one way communication and to address groups or individuals. And it is available, though primitively, as a partial alternative to the use of radio in the basic system for essential communications.

The Soviet international broadcasting service itself is far reaching. In late 1950 it was estimated that 50 transmitters in four cities were employed in this service. Of these 33 were for high-frequency transmissions, of which 20 were in the Moscow area, 13 for medium frequencies, and 4 for low frequencies. They were used for foreign broadcasting for an estimated total of 88 program hours per day in a total of 41 or more foreign languages. Appendix G lists these facilities along with data on the frequencies employed, the languages used, and the areas intended to be served.

While the Soviet Union is now operating three of four television centers and probably some experimental FM stations, the use of frequencies above 30,000 kilocycles for mass aural broadcasting purposes is quite negligible. There in no evidence to support the likelihood that the Soviet Union contemplates any sudden or radical changes in the above described system based on the use of frequencies below 30,000 kilocycles. 20/

(b) The Press Broadcast Service

The USSR broadcasts press material from nine different cities. These are beamed transmissions to certain areas of the USSR, the Orbit countries, and to other continents and countries. Appropriate languages are used in various forms of telegraphy, Morse, Hellschrieber (a form of facsimile), and perhaps teletype. Appendix H is a listing of data on these transmissions. With little or no difficulty this system and its facilities could be used for, at least, specifically-addressed one-way communications whenever necessary situations.

(7) The Amateur Radio System.

In the USSR the amateur radio service, through government interest, is under wide development. Through the Voluntary Society for Assistance to the Army, Air Force, and Navy (DOSAAF), and probably through other organizations, programs are carried out for the development of radio operators, radio technology, and radio clubs and circles. No estimate can be made of the number of amateur transmitting stations that exist in the Soviet Union. It is speculated that the number of such stations runs into the thousands. Appendix I shows that some 436 Soviet Union amateurs were contacted by US amateurs between 1946 and 1953. It is believed that Soviet policy is to reduce the number of individual stations in a given locale with the idea that one station could be well-equipped from the others. This arrangement affords better instruction to beginners and at the same time makes more effective the communication security control that can be obtained from group activity. 21/

(8) Special Service Stations

In July 1949 the USSR was broadcasting radio time signals from five different locations, meterorological bulletins from 21 different locations, and notices to navigators from seven locations. No information is available on the transmission of medical advice and frequency standards. 22/ In 1949 the USSR was operating special service radio stations at the following locations: 23/

Archangel	Kuybyshev	Odessa
Irkutsk	Leningrad	Tashkent
Khabarovsk	Moscow	Tushino
Khimki (Moscow)	Murmansk	

There may of course be other special services being conducted over the radio medium below 30,000 kilocycles by the USSR of which we are not aware.

b. Military

The military forces depend upon the civil wire system and long range radio facilities for most of their long distance circuits. Good reliability and adequate security of such circuits are achieved because of the maintenance being performed by a semi-military group known as Signal Troops and by virtue of the exclusive assignment of circuits for military use. In some instances separate radio facilities are used for coded military traffic. As will be seen from the map, (Appendix M) both civil wire and radio facilities are geographically readily available to the important military headquarters.* Communication from military headquarters to local subordinate units is usually accomplished by separate military open wire lines supplemented by short range military radio facilities. From a military standpoint, the long distance telephone lines must be supplemented by powerful long range radio facilities to provide against physical damage to the wire lines and failures during the rigorous winters. It is not known whether the Soviet Air Force has its own long range facilities. For navigation purposes a large number of low power radio direction finder installations are spread throughout the country for use by both civil and military sources.

[redacted] 25X1

* Air force headquarters are not shown east of the Urals because of the uncertainty of their locations.

2. Satellites (Includes Communist China, East Austria, and East Germany)

a. Communist China

General

It is axiomatic that a highly-developed rapid communications system in a country usually accompanies highly developed physical communications (railroad, airway, waterway, highway, etc.). But even if its physical communications are sparse and primitive, the exigencies of modern statehood are such that a well-developed rapid communications system is of vital importance. In China, neither of these two media are highly developed in spite of the fact that the country is second in size to the USSR, comprising over 3.7 million square miles, with a population second to none of about 480 million people. China's rapid communications system is principally concentrated in the larger cities of the eastern, northern, northeastern, and parts of the central and southern regions of the country. They thin out very rapidly toward the western portion. In the farther reaches of the northwestern, southwestern and western regions, rapid communications facilities are practically non-existent. The map in Appendix B gives an impressionistic picture of the general extent and local of its principal wire line and reported radio transmitting station locations and indicates the combined radio and wire line centers. The efficiency and speed of service varies considerably in different parts of the country. The present wire line and radio systems, never developed to meet or to stimulate public need, seem utterly inadequate to serve the overall needs of the country if it is to progress politically, socially, economically, and militarily. This seems particularly true if development is to take place at a rapid rate, since the role of rapid communications is to accelerate human activity and effectiveness. 24/

It follows from the lack of wire line facilities in the west and southwest areas that to serve these areas in the near future the use of radio will have to be the dominant means of telecommunications.

(1) Civil Facilities

As in the case of the USSR, no clear-cut distinction can be made as between civil and military rapid communications facilities and services. In Communist countries, the entire rapid communications complex with but few exceptions is state owned, state operated, and state serving. The military departments can and do avail themselves of facilities and services available to other segments of the government. However, for strategic reasons, the military enjoy certain "privileges" in providing, operating, and maintaining systems, networks, and facilities considered too strategically important to share with other users. Hence this section is divided into the civil and into the military aspects.

(a) Basic System

The basic system (telephone, telegraph, and facsimile) serving the general-purpose needs of the country comprised about 600 thousand kilometers of wire in various forms. In 1950 some 328 radio stations were believed to be operating in the Fixed Service for point-to-point communications. According to a 1949 estimate, however, over 673 cities and towns in China had radiotelegraph stations. It was estimated that about 6.5 million interurban and international conversations were handled in 1951. In 1946 12.9 million domestic telegrams were processed (11.1 million personal or commercial and 1.8 million official or military) and 1.4 million international messages.
The scope of the communications network is shown on map, appendix b.

Table 4 is a partial list of cities having relatively extensive wire and/or radio basic communications facilities. They seem to fall into the categories of main centers. While Shanghai still appears to be the principal center, there are indications that this distinction is being shifted to Peking. 25/

Table 4

Partial List of Probable Communist China Main Basic Wire and/or Radio Communications Centers

Shanghai	Harbin	Kueiyang
Peking	Mukden	Hsian
Canton	Dairen	Lanchou
Nanking	Hankow	Urumchi
Chungking	Kunming	

China has 115 circuits to foreign countries; of these, 42 are wire circuits and 73 are radio circuits. Gateway cities for handling of international communications are listed in Table 5. 26/

Table 5

List of Gateway Cities for the Handling of International Communications

Aihun	Dairen	Lhasa	Shekki
Amoy	Foochow	Lupin	Swatow
Antung	Fuchin	Nanking	Tsingtao
Canton	Haikow	Lungchon	Tuluerh
Chian	Kashgar	Pang-chiang	Tungning
Ch'i-ch'ien	Kongmoon	Peking	Urumchi
Chungking	Kunming	Shanghai	Yenchi

Appendix C contains a list of the (International Telecommunications Circuits) international facilities operated from these gateway cities. Included are the points of communications, the method of communication, and the media employed. Included on page 1 of Appendix C are some detailed statistics on these facilities. Nothing is known of Communist China's covert international facilities.

The cities shown in Tables 4 and 5 form the structural foundation of the basic domestic and international rapid communications system of Communist China.

Besides the basic general-purpose rapid communications system described above are specialized systems, networks, and facilities. Some are thought to be exclusively radio, others perhaps exclusively wire, and still others involving both. They serve segments of the government, industry, and the military. They probably maintain connections with the basic system, or can be so connected as necessary. Because they must depend upon the radio medium for rapid communications with and between mobile units, the aeronautical, maritime, and land mobile radio services loom large in strategic importance, both economically and militarily.

(b) Aeronautical Systems

There is thought to be some 116 operational airfields within Communist China and these are probably available to the air transport organization. Practically all of these airfields have radio communications facilities and most of them are equipped with beacon navigational aids. These airfields for the most part are located in the eastern part of China both north and south. Because of the proximity of one field to the ajacent ones the air-ground facilities might be used in a point-to-point chain of communications. Information is not available on existing airways, airways traffic control procedures nor on the communication procedures used by the air transports operating within Communist China. All of these operational airfields, both those controlled and utilized by the "civil" and military authorities, are immediately available to the needs and demands of the Communist Air Force.

Appendix F locates reported aeronautical radio stations providing communication and radionavigation service.

(c) Maritime Services.

The inadequacy of land transport in China has always placed dependence on the merchant marine for the movement of the goods of commerce from the centers of production to market. Passenger traffic by water is also thought to be extensive. China has had four divisions of water transport: river, coastal, nearseas, and oceanic. 27/

To support some of its shipping activity, China is believed to have operated in 1952 at least 23 coastal radio stations. 28/ The map of Appendix F locates many of these stations, along with reported radio stations of the Communist China navy.

It is believed that very little radio is used for inland marine operations.

(d) The Land Mobile Radio Services.

Nothing is known about the use of radio in Communist China for the operation of trains, vehicles, or other land mobile units serving the various segments of state interests. Undoutedly the Chinese army employs radio in connection with its administration and

(e) Meteorological Radio Systems.

Little is known about the rapid communications facilities associated with Communist China meteorological services. In 1949 there were 9 meteorological radio stations reported in operation, mainly in the high-frequency bands. During the same year there were 262 meteorological observation stations throughout the country. It is likely that some of these were operating radio facilities for the collection and distribution of weather reports. 29/

(f) The Broadcasting Systems.

Like the USSR, Communist China operates two basic kinds of radio broadcast service for rapid collective communications. In magnitude the facilities employed do not however reach the proportions of those employed in the Soviet Union. Unlike any other Orbit country Communist China employs a somewhat novel technique for the distribution of news to the far-flung reaches of the country. This is known as the radio monitoring network. It comprises designated radio receiver reception points which record and disseminate specially dictated news broadcasts transmitted over the mass aural broadcasting system. The two basic kinds of radio broadcast service-- the mass aural and the press broadcast services-- will be treated separately.

(i) The Mass Aural Broadcasting System.

Communist China operates a mass aural broadcasting system of significant magnitude. But from the standpoint of the huge area to be served, the domestic transmission system appears inadequate to provide a thorough nation-wide service. It provides internal or home service and some external or international service. The basic motivation behind these two area services is generally the same as that for the USSR--propaganda and education. However, the inadequacies of wire line and other radio facilities and newspaper distribution lay behind the development and use of mass aural broadcasting facilities for the dictation and distribution of "news". The map in Appendix B symbolizes the locations of the transmitting facilities. Appendix E is a list of China cities from which these transmissions emanate, along with the number of transmitters, and the frequencies and powers employed. Page three of Appendix E gives consolidated statistics on these facilities. They show that China employs 149 transmitters in 60 cities. The transmission power employed ranges from 100 watts to 50 kilowatts. Of these 149, none operate in the bands below 500 kilocycles, 114 in the bands between 500 and 1600 kilocycles, and 35 above 1600 kilocycles. Some of these transmitters may operate as part-time jammers. 30/ 31/

The transmission system is centrally organized into a nationwide network with Peking as the main, central station. Regional and local stations retransmit in part Peking transmissions, and in part originate their own programs. Shanghai is the only Chinese city with private stations. It is reported that there are 18 such stations still in operation in that city. However, program content is controlled all along the line. 32/

Wire line facilities play a part in the operation of this system. It is not known to what extent wire lines are used to distribute programs from one studio city to another. Some of the relaying, however, may possibly take place at times over wire lines. To serve the reception system, nevertheless, much wire is employed. Wire-diffusion networks use the wire medium to distribute programs received by radio or wire to loudspeakers located at street corners, large shops, recreational areas, factories, mines, business houses, etc. The extent of this system is not known at this time. 33/

Even more so than in the case of the Soviet Union, the Communist China mass aural broadcasting facilities in their totality--radio and wire components--hold important implications for any electromagnetic warfare considerations. By Western standards the sum total rapid communications resources of Communist China are inadequate and incapable of contributing to the fullest to any rapid and steep acceleration of the development of the national power of the country. They are available for civil defense warning notices, as many radio receivers and loudspeakers are located where groups of persons congregate. They are available for at least one way message communication to specifically addressed groups or individuals. The press dictation service is an example of this. They are available, though perhaps primitively and laboriously, as a partial alternative to and a full extension of the use of meager radio and wire systems for essential and emergency communications.

The Communist China international broadcasting service is inconsiderable. As of 1 February 1953 this serviee was conducted from Peking, North Shensi, Kunming, and Foochow. The broadcasts are directed principally to Indonesia, Indochina, Burma, Thailand, "overseas Chinese", Formosa, and Japan. Radio frequencies in the medium and high-frequency bands are employed. 34/ Appendix G lists these facilities along with data on the frequencies employed, the languages used, and the areas intended to be served. At present there is no low-frequency broadcasting service in China and there is no knowledge of any plans to exploit that portion of the radio spectrum for broadcasting. 35/

(ii) The Press Broadcast Service

Communist China operates a radio press broadcast service from Peking only. These broadcasts take place in English Morse and Chinese numeral code. They are directed to southeast Asia, Europe, and North America, and others are for "overseas Chinese organizations, foreign newspapers, and telegraphic new services." One group of scheduled broadcasts are addressed to "authorized recipients" without any indication of their location. Appendix H gives details on this service, including the transmitters, frequencies employed, and the schedules.

In the event of strategic or emergency needs these facilities and services themselves could be diverted to command and other communication channels.

Domestic news is not broadcast by this specialized service, being handled by the mass aural broadcasting system previously mentioned.

(g) The Amateur System.

The amateur radio service in present-day Communist China is almost non-existent. The 1949-1950 edition of the "Radio Amateur Call Book Magazine" lists a total of 210 amateur radio transmitters in Communist Ch na and an additional three listed in Tibet. However, late in 1949, the Communist Party in Peking issued orders suspending all amateur radio activity until such time as regulations governing "ham operators" were put out. As of June 1950, no such regulation had been issued. Between 1946 and late 1952 only 11 Communist China radio amateurs had contacted US amateurs. 36/ Appendix I lists by country the number of Orbit amateurs contacted by US amateurs.

(h) Special Service Stations

Data on Communist China special service stations are fragmentary. In 1949, there were four radio stations broadcasting radio time signals. No information is available on transmission of medical advice and frequency standards, nor on the operation of experimental radio stations. It is probable, however, that activities are conducted in all of these services on frequencies below 30,000 kilocycles as well as other services of which we are not aware. 37/

(2) Military Facilities

(i) Wire Communications

All wire lines in Communist China may be regarded as in current use by the military and are known to connect all major headquarters.* The traffic handling capabilities of the majority of lines are extremely low. This low capacity combined with erratic reliability, make long distance communication by wire difficult under present conditions.

The loss of supplemental radio circuits would cause an almost complete breakdown of all but the most urgent traffic and even this would be subject to frequent serious delays.

To further strengthen the existing facilities, decimeter radio relay equipment is being imported into China, but the known existence of any chain of radio-relay stations is yet to be established.

* See Map Appendix "M".

b. Other Orbit Countries (European)

General

From several standpoints the rapid communications facilities of these satellites may be considered as an extension of the Soviet facilities to the west, with of course the exception of isolated Albania. The direct hand of the Kremlin reaches out over this area to exercise its domination and control. These satellites (omitting Albania) all have one or more borders with other satellites or with the Soviet Union. They are all relatively small in size and the extreme internal distances to be covered are small relative to the USSR and Communist China. Together they comprise over 393 thousand square miles (Albania an additional 10.6 thousand). Czechoslovakia, East Austria, East Germany, and Hungary are reasonably industrialized, Poland and Rumania less so, and Albania and Bulgaria hardly at all. Albania is of little consequence as a rapid communications country. Physical transport development is generally consonant with the state of industrialization. With the exception of Albania they are all provided with wire line facilities to about the same extent as or better than the European portion of the USSR. Coaxial and micro-wave radio systems are employed in several countries. Except for Albania they may intercommunicate with each other and with the USSR over wire line facilities without the necessity of crossing through non-Orbit countries where control of the facilities would be in other hands. The use of the radio medium for internal or intra-Orbit basic and other point-to-point communications does not appear as necessary as it does in large areas of the USSR and Communist China. Though the systematization standards as between the Orbit countries and as between them and the USSR and China may vary, they can and probably are being made compatible where necessary. From all this it may be said that the need to exploit the radio resource is less dire than in the Soviet Union and Communist China. Because of the skip effects of the higher order frequencies below 30,000 kilocycles, such exploitation as takes place would tend to involve mainly the lower order frequencies, except of course for certain mobile, long-distance, intra-Orbit and other international communications. Vis-a-vis Western Europe, the European Orbit countries present a rather formidable structure of wire lines, as can be seen from Appendix B. Viewed from the Kremlin, this presentation is strategically important.

(1) Civil

(a) Basic System

The basic system (telephone, telegraph, telephoto) serving the general-purpose needs of these satellites is estimated to comprise of over 20 million kilometers of wire* in various forms. As of 1951, they were alledgedly operating over 100 radio stations in the Fixed Service (including Aeronautical Fixed Service). Some of these, however, may not operate into the basic system. It is estimated that the system handled over 144 million interurban and international telephone conversations and over 51 million domestic, international, and transit telegrams in 1951. 38/

Appendix B is an impressionistic composite graphical presentation of all reported, and partly unconfirmed principal wire facilities and overall radio stations in these European satellite countries. Probably all of the wire line facilities and only a portion of the radio facilities shown are direct components of the basic system. Many of these stations operate in other services to be described later.

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* Excluding wire lines devoted to wire-diffusion broadcasting.

Table 6 infra is a partial list of cities having extensive wire and/or radio basic communications facilities. Generally the capital of the country is the principal center, but more or less duplicate centers may have been provided against the possibility that the seat of government might have to be relocated for emergency of war reasons.

Table 6

Partial list of Probable European Satellite Main Basic Wire and/or Radio Communications Centers

Albania	Bulgaria	Czechoslovakia	East Austria
Durres	Gorna-Oryakhovitsa	Bratislava	Linz
Elbasan	Ploudiv	Brno	Vienna a/
Shkoder	Sofia a/	Olomouc	
Tirane a/	Stara-Žagora	Prague a/	
Vlone	Turnova	Zilina	
East Germany	**Hungary**	**Poland**	**Rumania**
Berlin a/	Budapest a/	Breslau	
Dresden	Debrecen	Danzig	Bucharest a/
Leipzig	Gyor	Poznan	Ciui
Madgeburg	Miskolc	Torun	Constanta
Stralsund	Szombathel	Warsaw a/	Oradea

a/ Capital

Gateway cities for the handling of "open" international communications are listed in Table 7. 39/ *

Table 7

Albania	Bulgaria	Czechoslovakia	East Austria
Tirana	Sofia	Bratislava	Vienna
Vlone		Brno	
		Nachod	
		Ostrava	
		Prague	
East Germany	**Hungary**	**Poland**	**Rumania**
Berlin	Budapest	Wroclaw	Bucharest
Leipzig	Matezalka	Ciessysn	Cluj
Lindau	Szeged	Gdynia	Constanta
	Szolnok	Katowice	Oradea
		Krakow	Satu Mare
		Lvov	Timisoara
		Waldenburg in Schlesien	
		Warsaw	

*"open" is defined as cities having through circuits for commercial uses.

Appendix C contains a list of the open (International Telecommunications Circuits) international facilities operated from these gateway cities. Included are the points of communication, the method of communication, and the media employed. Where the use of the radio medium is indicated, the spectrum below 30,000 kilocycles is for the most part employed. Included on page 1 of Appendix C are some detailed statistics on these facilities for the whole Orbit by country.

The cities listed in Tables 6 and 7 together with such other strategic emergency or war centers as may exist, form the foundation base of the European Satellite rapid communications structure for the basic domestic and international rapid communications system.

While not properly considered as a part of the basic system, certain additional "covert" strategically important international radio facilities probably exist. A partial list of these for the whole Orbit is given in Appendix D. These are thought to be strategic and emergency communications channels provided by radio stations installed in Orbit embassies or legations in foreign countries around the world. They are probably intended to communicate with Moscow and/or their home capitals. To safeguard these channels for vital use, it is likely that they are at present seldom used, if at all.

Besides the basic general-purpose rapid communications system described above are specialized systems, networks, and facilities. Some of these are thought to be exclusively radio, others wire, and some comprised of both media. Some may be nationwide in scope, others limited to area operations. They serve segments of the government, industry, and the military. They probably maintain connections with the basic system, or can be so connected as necessary.

There is sufficient evidence to assume that direct telephone circuits have been provided between Moscow and the hierarchy headquarters in each satellite country for high-level, priority service.

Because the European satellites must depend upon the radio medium for rapid communications and in some cases navigational aids, first to be described will be the aeronautical, maritime, and land mobile radio services.

(b) Aeronautical Systems.

In the European Orbit countries, air transport does not necessarily enjoy the same pre-eminence as it might in Siberia or China, but they enjoy a greater density of railroad, and waterway transport than does Siberia or China. As for rapid communications they are netted with wire line and radio facilities, so that air transport need not function as a primary carrier of rapid communications. There has been no indigenous civil air enterprise in Albania, nor does Albania posses an air force. The limited aviation developments there are entirely regional in scope, reflecting Soviet intentions rather than Albanian efforts to create an air communications system. 40/ All of the others operate "civil", para-military, and/or military aircraft on their own account or on behalf of or for the Soviet Union. 41/ 42/ 43/ 44/ 45/

The Soviet civil air bloc in Europe, serving as an air barricade for the western boundary of the USSR, includes the Coninform states of Rumania, Bulgaria, Hungary, Poland, and Czechoslovakia, as well as Albania. The Soviet bloc states in Europe fall into two categories of Soviet domination. Rumania, Bulgaria, and Hungary comprise states whose civil aviation efforts are under direct Soviet control. Poland and Czechoslovakia, which are ex-Republican states, have less direct Soviet control over their national civil air effort. 46/

The map in Appendix F locates reported aeronautical radio communication and radionavigation stations in the European Orbit countries. It is estimated that there are over 100 radio stations in these countries serving air transport. Because of the existence of a comprehensive network of wire line facilities, it is probable that that medium is used extensively in serving air transport in one way or another.

(c) Maritime Services

All of the European Orbit countries utilize water transport for either inland or ocean service or both. Because they have direct or indirect access to the oceans, Albania, Bulgaria, East Germany, Poland, and Rumania are the most important satellites. For this same reason they all have some semblance of a navy. Ready information is not available on the water transport of Albania. Bulgaria's merchant fleet comprises only a few vessels of 1,000 gross tons and above. 47/ The Danube River is the country's only artery of inland water transport, over which a considerable amount of foreign trade and some of its domestic trade flows. 48/ East Germany has no ocean-going merchant fleet and in consequence must depend upon vessels of the USSR, the satellites, and other flags for the movement of her ocean commerce. Her fishing fleet is estimated to consist of 200 vessels. She also operates river vessels. 49/ As of 1 February 1951, Poland had a merchant fleet of 58 vessels of 1,000 gross tons and over. In normal trading its merchant marine operates on a world-wide scale, offering both liner and tramp service. Small maritime nations such as Poland and other satellites of the USSR place a great deal more emphasis on their smaller vessels than do larger maritime countries. Poland operates an estimated 30 smaller vessels of tonnages between 100 and 1000 gross tons. 50/ Rumania operates only seven vessels in its sea-going fleet, but its Danube river fleet is composed of a comparatively large number of smaller vessels that make a vital contribution to the nation's shipping. 51/

The map in Appendix F locates some of the reported coastal and river radio stations employed for maritime communications with vessels equipped with radio in these satellites. It is estimated that some 35 or 40 full-fledged coastal stations are available in these satellites for communications with nearby and distant vessels. Many more than this number probably give service to river, harbor, and fishing craft. 52/ Data on the available radionavigation aids have not been collated, but the map in Appendix F locates some of these stations.

(d) Land Mobile Radio Systems

Collated data on land mobile radio systems in the European Orbit countries are not available. While there seems to be a general practice to use radio in connection with wire lines for the operation of railroads, it is probable that the army is the greatest user of these systems. Segments of the government and of industry also probably employ land mobile radio with various kinds of land vehicles. Bulgaria seems to be one of the princip users of radio for railroad operations for both point-to-point and fixed station-to-station purposes. 53/

(e) Meteorological Radio Systems.

Raw material has not been collated on these systems for the European Orbit countries. The presence of extensive wire line facilities in this area tends to remove most of the dependence upon radio for the collection and distribution of meteorological data. However, radio is used to broadcast weather reports for general and for specific consumption.

All the European orbit countries maintain extensive nets of weather observation stations which report information regularly by some form of rapid communication, either radio or wire line. The extent of the use of radio for either radiosonde or communications by this service is not known. Table 8 infra, shows the number of weather observation reporting stations in each country and the number of these stations believed to use radio facilities for communication of their observations.

Table 8

Number of Weather Observation Reporting Stations and Number of Such Stations Employing Radio Communication Facilities for Countries Indicated

Country	Number of Weather Observation Reporting Stations a/	Number of Weather Observation Reporting Stations Using Radio Communications Facilities
Albania	7	If any, n.a.
Austria (all zones)	67	none
Bulgaria	34	5 b/
Czechoslovakia	28	If any, n.a.
Germany (all zones)	214	If any, n.a.
Hungary	48	6 c/
Poland	61	56 d/
Rumania	83	15 e/

a/ "Radio Weather Aids," Volume II (H. O. 206), U.S. Navy Hydrographic Office, 1952, U.

[redacted] 25X1

(f) The Broadcasting Systems.

General

Like the Soviet Union and China, all of the European satellites employ radio for mass aural broadcasting, and some of them employ radio in their press broadcast service. The purposes of these services are generally the same as those of the USSR and China. In addition to the latter type of specialized and limited service, involving more specific addressees, some of these countries probably conduct other services for more strategic purposes of the state, such as broadcast intercept service for merchant and naval vessels and for outposts and advance bases.

(i) The Mass Aural Broadcasting System.

All of the European Orbit countries operate mass aural broadcasting systems. The basic motivation behind the operation of these systems is the same as that for the USSR and China-- Communist indoctrination and agitation. They all give domestic service and international service. Because of the transmitting powers employed and relatively small size of these countries, many of the domestic transmissions probably can be heard well beyond their borders. The map in Appendix B symbolizes the locations of these transmitting facilities. Appendix E is a list of the Orbit countries from which these transmissions originate, along with the number of transmitters and the frequencies and powers employed. Page three of Appendix E gives consolidated statistics on these facilities, which show that these countries employ some 105 transmitters in some 59 cities. The transmission power employed ranges from 100 watts to 440 kilowatts. Of these 4 operate in the bands below 500 kilocycles, 74 in the bands between 500 and 1600 kilocycles, and 27 above 1600 kilocycles. Some of the transmitters employed in this service may operate as part-time jammers. 54/ 55/

Certain programs from stations in the Soviet Orbit are rebroadcast by stations in other Orbit countries. This is particularly true of Moscow programs. Some of this rebroadcasting is done by wire and some by radio link, and is generally true of domestic programs as well. Detailed source material is available showing the extent to which this is done. 56/ This systematization gives Moscow a "command" channel down the echelon to localized reception points in the Orbit countries. Calculations of the total number of domestic program radio medium transmission hours per day may be made from source. 57/, along with the languages and frequencies employed.

The wire line plays a strategic as well as a political and economic role in the European Orbit countries mass aural broadcasting system as it does in the USSR and China. Wire lines are employed to relay transmissions from one studio to another in the same country and from a studio in one country to a city in another country. The principal use of wire lines is for the distribution of radio broadcast programs to loudspeakers, rather than to individual radio receivers which obviously depend upon the radio medium. For the most part these wire lines seem to be independent and separate from the wire lines used for telephony and telegraphy, though in East Germany and perhaps in other satellites normal telephone and telegraph lines are sometimes employed to provide both services. By connecting wire lines to the transmitting studio, loudspeakers in the immediate surrounding area are served. The wire link is also employed to transmit programs to more distant wire-diffusion exchanges. Other remote areas are served by wire-diffusion exchanges which pick up more distant programs by radio, amplify them, and distribute these signals to wired loudspeakers. These arrangements are similar to those used in the Soviet Union and it seems clear that the Soviet hierarchy is pushing this development in the Orbit countries. Appendix J is a tabulation by Orbit country of the extent of this wire-diffusion system in relation to the use of the normal radio receivers.

As in the case of the USSR this wire mesh has important implications for the question of electromagnetic warfare, though perhaps not to the same extent. Since the European Orbit countries enjoy better coverage of telegraph and telephone wire lines, the importance of wire-diffusion lines does not loom as large as it does in those areas of the USSR where wire lines are inadequate or non-existent. Nevertheless they are available for civil defense purposes, for one-way individual or group communication, and as a supplement of or an extension to the basic system for essential communications.

The European Orbit international broadcasting service is considerable. Appendix G is a tabulated list of international aural radiobroadcasting services of all the Orbit countries. Included in the Appendix is a recapitulation of the number of cities involved, the frequencies and languages employed, the program schedules, and the areas intended to be served.

Development in television and the use of frequencies above 30,000 kilocycles for mass aural broadcasting appear to be underway in several European Orbit countries, at least experimentally. This is true of at least East Germany, Czechoslovakia, and Poland. But these developments have not reached the stage where they compete with or replace the basic broadcasting system operating on frequencies below 30,000 kilocycles.

(ii) With the exception of East Austria all the European Orbit countries conduct press broadcast services. Details on these services are shown in Appendix H. They are usually beamed to the areas intended to be served. Russian, French, English, and Polish Morse; and Russian, German, English, French, and Rumanian Hellschreiber are used. Since these are established services, they could be diverted to the handling of strategic individual or collective communications, at least on a one-way basis, in emergency or war situations.

(g) The Amateur Radio System

Freedom of radio speech by the Orbit radio amateur appears to have been curtailed and restrictions of various kinds have been imposed. They seem to vary from country to country, and range from conditions under which amateur radio transmitters may be operated to the radio bands to be employed, the countries with which they may communicate, what may not be communicated, and political party affiliation. Available data has not been collated on this subject. The number of existing amateur radio transmitting stations or transmitters is not known, but the number is thought to be in the tens of thousands in the European Orbit. As a training mechanism for young men and women for later employment in electronics and communications, the radio amateur activity could serve as a source pool of trained or partly-trained technicians. Appendix I shows the number of Orbit country radio amateurs contacted by US amateurs between 1946 and 1952.

(h) Special Service Stations

Data have not been collated on the existence and operation of special service radio transmitting stations in the European Orbit countries. It is safe to assume that a number of experimental, frequency standard, time signal, and other special stations use the radio spectrum below 30,000 kilocycles for transmissions.

(2) Military

Wire Communications - East Germany

Because of the number of Soviet Military Installations in East Germany, separate wire communications have been installed for exclusive Soviet use.

In addition to the Soviet Military Net, firm control is maintained over the civil wire net which is modern and extensive. All major military headquarters are adequately connected by wire. *

East Germany would be, of all the Satellites, the least affected by the loss of radio below 30 Mc.

Wire Communications - Hungary

The Hungarian Army normally uses civil circuits for its peacetime requirements and it is adequate. In isolated areas, the Army operates its own circuits, but these are considered to be for short band local requirements.

* See map Appendix M

In the event of immediate loss of radio facilities the East-West circuits could absorb the additional traffic; it is felt that North-South traffic in the Western half of the country would be hard pressed. An analysis of the rail network in Western Hungary indicates that the railway telecommunication facilities can absorb a fair amount of emergency traffic.

Construction of new facilities in Hungary is being undertaken with major consideration being given to future military potential.

Wire Communications- Czechoslovakia

Military forces in Czechoslovakia do not maintain a wire communication net phsically separated from the civil system.

With but one exception, major military headquarters are located on line routes served by modern underground cable. Open wire lines which radiate from all major centers make it possible to route traffic around sections of underground cable in case of cable failure.

Since 91 percent of all Czech communities tie into the telephone net, Czechoslovakia would not be any more than inconvenienced by the loss of radio facilities.

Wire Communications - Poland

The Soviet Union has built an extensive open-wire network which is separate from the Polish civil network and is presently expanding it. It is considered that this net is exclusively a military net with the exception that high priority Soviet administrative traffic may be handled.

In addition to the separate military network, the civil network is adequate to support rear echelon traffic between the major headquarters.

Other considerations which reduce dependency on radio below 30 Mc, are the existence of a separate railway wire communications net, the possibility that the wire broadcast net may be separate and an undetermined amount of decimeter equipment.

Wire Communications - Rumania

There is no wire network maintained by the Rumanian Army which is physically separate from the civil system.

The Rumanian Army has civil circuits which are permanently assigned for its use. The major military headquarters are all located at major communications centers of the civil wire networks and would have no difficulty maintaining emergency traffic in the event of loss of long haul radio circuits.

Wire Communications - Bulgaria

Existing wire facilities will logistically support the present locations of major military headquarters. If adverse conditions forced major headquarters to relocate toward the Southern and Eastern borders it is doubtful if existing wire facilities could absorb the traffic.

There is no separate military wire network.

Wire Communications - Albania

The armed forces of Albania have a separate wire net which adequately covers the country, and is effective for internal security.

There is no international wire line which connects to the rest of the Soviet Bloc, and loss of radio circuits would isolate Albania from the rest of the Orbit.

Wire Communications - Austria

There is no separate wire network in Austria built exclusively for military use.

The Eastern Zone of Austria has a considerable network of well integrated underground cable which inter-connects all main communications centers.

The distances between present major headquarters are not too great to preclude the effective use of microwave lines.

Naval Systems

Almost nothing is known about current satellite instrumentation. The greatest reliance appears to be upon Soviet equipment, but in Europe some equipment from the Satellites themselves, former German equipment, and scattered West European equipment has been reported. In China, U.S. Chinese, World War II Japanese, and Soviet communications equipment are all expected to be used, although nothing is known concerning current shipboard communications installations. Satellite naval communications are expected to parallel usage of the Soviets, but equipment will be more diverse and probably of lower quality.

A lively interest in the very low frequencies for shore stations to be used in naval service is evident.

3. Facilities Used in Jamming

General

Jamming is a disservice, the deliberate interference to or obstruction of a channel of radiocommunication, particularly when the jamming transmissions themselves are conveying no intelligence per se. It is an infringement of the spirit if not the letter of the International Radio Regulations, to which the USSR officially is a party. While jamming is therefore not a recognized service, it is appropriate to consider it a sort of negative service. In economic effect, it is an attempt to deny the use of a common, world, economic resource to others. There are indications that transmitters used as jammers are also used in one or more of the systems previously described in this paper. 58/ This is consistent with the early statement in this report that any radio transmitter must necessarily be considered as a potential jammer.

a. Employment of Jamming Transmitters.

There are two general methods of selecting sites for jamming transmitters operating in the high frecuency range. The first method is to locate the jammer as near as possible to the a mitter; this method has the advantages that the jamming signal tends to cover the same audience area as the target signal and that very few jamming transmitters are required having powers equivalent tothe target signal. The second method is to locate the jamming transmitter as close to the receiving audience as possible. This method has the advantage of requiring lower power transmitters when the audience area is small, but the disadvantage of requiring a large number of transmitters when the audience area is large.

b. Quantity of Jamming Equipment.

Estimates of the number of transmitters employed by the Soviet Orbit in the jamming operation range from 250 to 1500 with a reasonable average figure given as about 880 transmitters. They are believed to be located at various places in the Soviet Union but none are specifically identified with the central and northern regions of Siberia. Others are located in several of the Orbit countries. The power of these transmitters varies widely but statedly up to 100 kilowatts and more in some cases. The jamming signals have been heard in all portions of the radio spectrum usually used for broadcast activities. Signals have been heard as low as 230 kilocycles and through the spectrum from 300 up to 21,700 kilocycles. Jamming is generally directed against foreign programs employing any of the languages used by the various population groups within the Iron Curtain at any time during the 24-hour day. Concerted jamming control apparently requires rapid communications facilities. These are thought to include radio below 30,000 kilocycles, microwave radio, telephone lines, special wire line networks, and ordinary mail. Current jamming levels are believed not to interfere appreciably with Orbit legitimate radio services. 59/

Several important features of the jamming facilities can be derived from the analysis of the effectiveness of the jamming activity. There is no question that a substantial number of the jamming transmitters have transmitting powers in excess of 10 kilowatts. This fact indicates the use of the first general method of employment previously mentioned, involving the selection of sites at some distance from the target audience. This method requires fewer transmitters and could therefore be achieved by diverting transmitters for limited periods from their normal long range service. In connection with the probability of diversion it is to be noted that large scale jamming effort is currently applied only four half-hour periods each day, and that the loss of radio service will not be felt in certain time zones because of the time of day. The total number of high power, short wave radio stations in regular service is estimated to be more than 300 since the International Telecommunications Union has received Soviet notifications on more than 400 call letters for powers of 15 kilowatts or higher in the frequency range from 6 to 13 megacycles. If 200 transmitters were diverted to be applied as jammers to 80 simultaneous Russian-language transmissions only 40 additional special jamming installations or reserve transmitters would be needed to produce 3 jamming signals per program carrier.

In addition to the high power long, range jamming transmitters, approximately 400 to 600 low power high frequency transmitters are probably required for small individual areas not lying within the transmission coverage of the high power stations. This group of low power transmitters is not large when compared to an estimated total of 10,000 transmitter equipments available at the 2,300 reported transmitter sites.

c. Locations of Jamming Transmitters

The high power jamming transmitters are located chiefly in the major communication centers which are clearly identified on the map, Appendix B. Locations of the low power jammers in the USSR are not definitely known but the majority are believed to be in the sparsely settled areas.

Table 9

Presumed Location of Jamming Transmitters in the European Orbit

Albania	Bulgaria	Czechoslovakia
Shkodar	Gorna Malina (near Sofia)	Mikulov
		Strasnice
		Plzen
		Prague

East Germany	Hungary	Rumania
Berlin	Budapest	Bucharest
Koenigswusterhausen	Kamaracrdo	Casla
Harz Mountains	Matyasfold	Stalin
Leipzig	Szekesfhervar	Tulcea
	Szolnok	

There are indications that at least some transmitters used as jammers are also employed in other more legitimate services, such as mass aural broadcasting. The jamming system is something of a system because the jamming service appears to be organized for coordinative effort between numerous transmitters located at widely scattered places.

[redacted] 25X1

25X1 [redacted] jamming transmitter locations in Peking, Tientsin, Shanghai, Shenyang, and all large cities in North China. It is not known whether these transmitters are used exclusively for jamming or whether they are also used in other services, or held in strategic reserve when not used as jammers. Particulars on the systematization of the jamming function are not available.

B. The Orbit Communications Equipment Resources

1. Production

a. Electronics Industry

USSR

The Soviet electronics industry is a growing industry comprising an estimated 120 to 150 plants (excluding battery plants and plants producing light bulbs or parts and components with non-electronic applications.) Of this number, 100 to 130 plants are engaged in the assembly of end-products and major sub-assemblies. The balance produce tubes, other components and parts.

Seventy to ninety of the 100 to 130 electronic assembly plants are believed to be producing primarily military articles, while 40 to 60 are manufacturing articles primarily for the civilian economy and the communications network. 60

The complex administrative organization of the Soviet electronics industry since Stalin's death has been subordinated to the newly created Ministry of Electric Power Stations and Electrical Energy. This is similar to the organisation that existed before 1948 when the Ministry for Communications Equipment Industry was organized. The Ministry of Electric Power Stations and Electrical Energy now includes the former Ministry of Electric Power Stations, the Ministry of Electrical Industry and the Ministry of Communications Equipment Industry. The Ministry of Communications apparently remains without change.

The geographical distribution of the value of output of the electronics industry in 1951 is given in the following table:

Geographical Distribution of Value of Output of the Electronics Industry - USSR 1951

Economic Region	Percentage of Total Value of Output
Ia	23
Ib	0
IIa	small
IIb	0
III	8
IV	small
V	2
VI	5
VII	35
VIII	7
IX	15
Xa	0
Xb	5
XI	small
XII	0
	100

As can be seen from the table, the electronics industry in the USSR is rather heavily concentrated in Region Ia which includes Leningrad, Region VII which includes Moscow, and to a lesser extent Region IX which includes Novosibirsk and Region Xb which includes Tashkent. (For area included in economic regions, see map in Appendix N)

It has been possible to estimate the capabilities of the Soviet Bloc tube Industry as $82 million for 1952. This may be extended to provide an estimate for the overall electronics industry of $750 million in 1952. Of this capability USSR contributes 80%, or $600 million. This is about 10% of the U.S. electronics output, which is $8 billion ($4 billion is radio and television).

East Germany

The largest concentration of electronics plants in East Germany is around Berlin. However, important electronics facilities or their suppliers are situated in several other cities of East Germany, such as Radburg, Treptow, Erfurt and Arnstadt. East Germany is the largest satellite manufacturer of electronic and telecommunication equipment with about 70 plants. 61/ Diversification of the industry is indicated by the fact that the value of estimated 1951 and 1952 production is composed of the following elements: Radio equipment -- 37%, telephone equipment -- 33%, wire and cable -- 19%, and tubes -- 11%. It should be noted that, at the present, the USSR apparently has a policy of 1) trying to lessen its dependence on the German electronic industry and 2) failing to supply the German electronic industry with raw materials in the amount needed for capacity production.

Hungary

In Hungary the electronics industry is centered in Budapest and Ujpest. There are approximately 25 plants manufacturing electronic and telecommunication equipment in Hungary.

Hungarian electronic production is being given assistance by the USSR. 1952 tube capacity will be greater than peak war production. The subsidiary companies of the many large German and English firms have been nationalized and are in full production. Wire and cable and telephone equipment production accounts for over 50% of the total electronic production. The greatest part of the electronic production is earmarked for the USSR. It is assumed that at least 75% of production is for military purposes. The industry is employed as follows: Tubes -- 12%, radio -- 13%, telephone and telegrpah -- 30%, wire and cable -- 24%, and radar industrial electronic equipment -- 20%.

Czechoslovakia

Prague is the most important center of electronics production in Czechoslovakia; the headquarters of Tesla, the organizations which administers all electronics plants, is located in that city. There are also important plants in other cities, such as Vrchlabi, Pardubice and Roxnov pod Radhostem. There is no appreciable geographical concentration other than around Prague. There are approximately 40 plants manufacturing electronic and telecommunication equipment in Czechoslovakia. 62/

The Czechoslovakian electronic industry is believed to be expanding at a rate of approximately 10% per year at the present. Diversification of the industry is indicated by the fact that the value of estimated 1951 and 1952 production is composed of the following elements: Wire and cable -- 47%, radio -- 31%, tubes -- 12%, and telephone equipment -- 10%.

Poland

The official Dutch-Polish Trade Agreements has come to a stand-still owing to Polish failure to fulfill committments for the delivery of coal and has been partly replaced by private arrangements. The Philips works in Poland, how nationalized, have been hard hit by the failure of this agreement as Philips, Eindhoven, was obliged to withhold essential supplies of materials and components for lamps and tubes which, together with technical assistance, was provided for in this trade agreement made more than two years ago 63/

The Polish electronic industry was never large enough to compete with the larger European countries, and 67% of this was destroyed during the war. In 1951 only two state owned factories were making radio sets. Percentages are given for electronic production: Tube -- 2%, radio -- 14%, wire and cable -- 80%, and telephone and telegraph -- 4%.

SECRET

East Austria

The percentage of the production of the Soviet Zone of Austria, based on the number and nature of Soviet-controlled factories is 25% of the output of the country's over-all industry, divided about as follows: Tubes - 8%, radio - 23%, telephone and telegraph - 26%, and cable and wire, 43%.

Bulgaria, Rumania and Albania

In comparison, electronic production in Bulgaria and Rumania is insignificant. There is no production of electronic equipment in Albania.

China

The manufacture of electronic equipment in China has never been a significant industry, except under Japanese rule. Dependency upon imported components, loss of production machinery through Soviet looting, lack of refined raw materials, and insufficient technical and managerial manpower are primary deterrents to the growth of the industry. USSR is apparently willing and able to supply the necessary components to enable the Chinese to utilize maximum capacity for the manufacture of simple military electronic products.

The present Chinese electronic industry is a combination of centralized manufacturing facilities and "cottage type" industry. China is negotiating with the DDR to design a combine for the manufacture of telecommunication equipment in China.

Production of the Chinese Industry is divided in the following manner: Telephone and Telegraph - 17%, wire-57%, radio -26%.

b. Radio Transmitters

Radio transmitters used in generation and transmission of electromagnetic waves are of direct importance to this study. The transmitters emit radio signals which can be used to jam radio waves. The techniques of jamming will not be discussed in this section; however, it is important to realize that transmitters can be used either for broadcasting radio waves, and for jamming desired reception. For this reason there is no distinction made as to the transmitters that may be used in jamming operations.

The great requirement for transmitter equipment of many kinds dictates a high priority for its production in the Soviet Orbit electronics industry. The equipment produced ranges from complete radio stations to small communications transmitters and transceivers used by the military forces. As in other phases of the electronics industry, production is primarily for military purposes.

Transmitter production in the Orbit as a whole has increased considerably since World War II. If future Soviet planning for radio equipment approximates the goals set by the Soviet Five-Year Plan ending in 1950, it may be assumed that transmitter production will continue at a high level. Judging from the large number of jamming transmitters which have been put into operation against Voice of America broadcasts, the Orbit has succeeded in manufacturing several hundred transmitters of 10 KW power and above since 1948.

The Soviet Orbit now produces all of its transmitter equipment and major components. The major contribution comes from the Soviet Union, although the output of certain Satellite countries is highly significant in both quantity and types of equipment produced. It is known that some Soviet-made equipment employs components made in Satellite plants. For instance, the Soviets have used Hungarian and East German factories to make transmitters for Satellite and Soviet radio operations.

The USSR has a significant number of apparently quite capable plants producing radio transmitter equipment. There are at least 12 different manufacturing installations in various Economic Regions employing in excess of 13,000 workers. The major known plants are at Voronozh, Sverdlovsk, Gorkiy, Leningrad, Novosibirsk, Moscow and Riga. A Leningrad radio plant has made a number of transmitters of 5 KW or below, which have been installed in the Moscow, Urals and Minsk areas.

25X1

25X1

Electronics industry activities in the Soviet Orbit, having a direct bearing on the problem of electromagnetic warfare capability, are the production and development of high-power electron tubes for use in high-power and shortwave transmitters. Information on these activities is presented in the following paragraphs.

The two major manufacturers of high-power transmitters in the Satellites are the Standard Radio Factory in Budapest and the Koepenick Radio Factory in Berlin. In Hungary four Budapest radio factories--Standard, Orion, Remix and Telefongyar--manufactured about 700 transmitters for the USSR between 1949 and the end of 1951. Of this number, two were 120 KW and three were 135 KW radio transmitters, the remainder being smaller types for military shortwave, jamming and mobile operations. Hungarian production for this three-year period, including high-power and short-wave transmitters for local and other Satellite consumption, is summarized below:

Year	Number	Type of Transmitter	Operating Country
1951	1	1 KW (3 Band)	Albania
	180	Jamming	USSR
1950	2	1 KW Military Radio	USSR
	5	2 & 5 KW Military Radio	USSR
	19	Short-wave	USSR
	263	Military Portable	USSR
1949	1	50 KW	Hungary
	2	135 KW	Hungary
	2	120 KW	USSR
	2	135 KW (for operation in cold, wet climate)	USSR
	2	High Power	Rumania
	9	Low Power	Rumania

East Germany equals or exceeds Hungary in capacity for transmitter equipment manufacture, although this type of production makes up only a small part of her large electronics industry. The principal factory in East Germany, Berlin Koepenick, along with a number of the other important East German factories such as Radio Work Leipzig, the Sachenwerk Radeberg and the telecommunications factories at Treptow and Dabendorf, have made, in the past three years, an appreciable number of shortwave and high-power radio transmitters.

The Dabendorf plant specializes in ship-borne installations of the short-wave units which were designed for police operations in East Germany and Czechoslovakia. Deliveries were also made to the USSR as well as to China, Poland and East Germany. The total production of transmitters for the three year period (1950-1953) has been about 600 units with rated power exceeding 2500 kilowatts. Some of the important transmitters known to have been produced in the years indicated are, as follows:

Transmitters - East Germany

Power	1952	1951	1950
500 KW	1 (delivery in 1953)		
350 KW	1* (for installation in East Germany)		
150 KW	2		
100 KW	5		
50 KW	3		
20 KW	4	10	
3-5 KW	10		
800 watts**	61	12	18 (1945-48,22 weremade)
200 watts	12	12	
80-100 watts	31		370

Quantities of capacitors, resistors, and other components are used in all electronic equipment and, apart from special types, can be produced in the relatively small manufacturing establishments. Although USSR has been able to maintain output at a high level, production has necessarily been supplemented by the Satellites, Germany, Hungary and Czechoslovakia. Orbit shortages in some types may be indicated by the imports from Finland, France, Italy, and other western countries.

c. Electron Tubes

The production of electron tubes is an important indicator of communications equipment resources. The total output of electron tubes in the Soviet Bloc is estimated as follows:

Total Output of Electron Tubes
in the Soviet Bloc
(Rate of output at end of year)

Year	All Types: Number of Tubes (in Millions)	All Types: Dollar Value (in $ Millions)	Transmitting and Special Tubes***: Number (Millions)
1951	50	62	2.4
1952	64	82	2.9
1955	115	170	5.5

The following table gives the electron tube industry capacity and manpower data of the Soviet Bloc as of January 1953:

Country	Estimated Capacity: # of Tubes (Millions)	Estimated Capacity: % of Sov. Bloc	Labor Statistics: Managerial & Skilled	Labor Statistics: Semi-Skilled & Unskilled	Labor Statistics: Total
USSR	43.3	67.7	8,125	20,875	29,000
E. Germany	8.0	12.5	4,850	6,650	11,500
Hungary	9.3	14.5	2,700	3,800	6,500
Czech.	3.0	4.7	1,000	3,000	4,000
Other Bloc	0.4	0.6	500	1,000	1,500
Total	64.0				52,500

The Soviet Bloc product mix of this production is: receiving tubes 43%, all other types 57%. The USSR product mix is receiving tubes 37%, all other types 63%. There is no indication that the Soviet Bloc electronics program,both military and civilan, has been hampered by tube shortages since 1950

ily about 15% of the total tube production is allocated to the consumer market with the over whelming large percentage of 74 % going into the military electronic equipment. The balance of the Bloc tube production or about 11 % is used for essential services and for export to Soviet controlled areas. There are indications that about 2/3 of the military allocation of tubes is for radar systems, leaving the other 1/3 for radio, decimeter and telecommunications equipment.64/

[redacted] 25X1

The limiting factor in transmitter manufacture is the electron tube, as transmitters require not only tubes to operate, but replacements as the tubes are used through their useful life. Specified numbers and types of transmitting and other tubes are required for each transmitting set or station, and the generation and emission of electrical energy by these tubes establishes them as a most essential operational component of transmitters.

In quantity, requirements for transmitting-type tubes are not great compared to receiving-type tubes. The numbers of tubes needed with power outputs of 10 kw and over are insignificant in comparison with the multiplicity of types and numbers for equipments operating below 10 kw. There are frequently but four primary power amplifier tubes in a 50 kw radio broadcasting station, and ten tubes may suffice for an efficient airborne communication transmitter.

Variation in kind, as compared to quantity required, is considerable. Known Soviet types of high quality transmitting and power tubes number well in excess of 400. Related types, produced under similar manufacturing conditions and including klystrons, magnetrons and some other specialized tubes, are generally classified with conventional triodes, tetrodes, pentodes, oscillators and rectifiers as "transmitting and special tubes." In varying degree, such tubes perform the essential transmission function.

A notable increase of capacity for transmitting and allied tube types has taken place since World War II, this increase being both in number of plants, diversity of types, quantity and quality of product.

Although the total direct labor force contributing to transmitting and special tube manufacture in the Orbit is not readily separated from labor devoted to other tube manufacture, it is estimated that approximately 6,750 persons comprising managerial, skilled and unskilled classes are engaged full time in such production. This force is over one-eighth of the total Orbit electron tube industry labor force of 52,000 persons. The minimization of sub-contracting by Soviet tube plants, in contrast to European Satellite tube plants, acts to raise the indirect and thus, total labor count, contributing to the finished product in the Soviet industry.

USSR

There are five major plants in the USSR known to be producing transmitting and special tube types in quantity. The total USSR production of an estimated 2.09 million units in this category is geographically dispersed in the five manufacturing centers of Moskva, Leningrad, Shchelkovo, Novosibirsk and Tashkent. There may be limited production at Saratov, Riga and institutes in the Moskva and Leningrad areas.

The USSR is known to have exported transmitting and special tubes in intra-bloc trade, the recipients being such electronically underdeveloped countries as Rumania and China.

The Leningrad Tube and Lamp Plant Svetlana 211 is the oldest and largest of all electron tube manufacturers in the USSR and has been producing high quality transmitting tubes since 1937. The production of low-, medium-, and high-power transmitting tubes is estimated to total at least 450,000 units annually. Together with special tube output the annual production of tubes other than receiving approximates 900,000 units. Of the total estimated labor force of 8,000 persons about 1700 workers contribute directly and indirectly to transmitting tube output, with some two to three hundred employees engaged in the final assembly force.

The Soviet tube plants specialize in the manufacture of particular tube types. Svetlana has long specialized in X-ray tubes, mercury vapor rectifiers, high-power oscillating and generating tubes for radio broadcasting stations.

The Shchelkovo Electronic Plant NII 160 was established with the aid of U.S. engineers before World War II and is now the most important research and development center for the Electron tube industry.

Research, development and production work is done in virtually all power classes of transmitting tubes. It is believed that NII #160 concentrates on transmitting tubes up to 100 watts, although a 1,000 kw water cooled triode suitable for low and medium frequencies was reportedly developed here in 1948 for jamming purposes. The Russians have or are attempting to construct a jamming transmitter employing pulse modulation having a peak power power of 500 kw which will cover the standard broadcast band as well as a portion of the high frequency spectrum. 66/ Noise diodes developed by the Germans are manufactured in the USSR and are used in receivers and for generation of noise in modulators for jamming transmitters. 67/

East Germany

Within the Soviet Orbit, Germany plays an important role in the production of transmitters and transmitting tubes.

Production of transmitting tubes is concentrated at the Erfurt tube plant where current production runs about 3,000 transmitting and oscillating tubes per year. The Berlin plant HF is the only other East German producer of transmitting tubes under 30 MC. Its 1952 plan called for only 200 units, while 250 units are planned for 1953.

Quantity manufacture of metal-ceramic u-h-f triodes was initiated at the Berlin plant HF for equipment and maintenance tubes associated with the decimeter-relay RVG-902 series program, airborne radio and radar equipment. In 1952, 60,000 of these tubes were planned; about half were types LD-11 and LD-12, as used in the RVG-902 decimeter equipment and perhaps other similar systems; 4,500 were of type LD-9, a more powerful version of the LD-12 decimeter-communications tube, and having specific test ratings of 40 watts output at 17.5 cm or 15 watts at 9.2 cm. In 1953 and 1954, 160,000 and 500,000 tubes will be required respectively. _/

Soviet Germany has a large capacity to produce high-power, low-frequency transmitting tubes presently not utilized because of a lack of demand. A significant proportion of this class of tubes is exported annually to the USSR, Poland, Rumania and China. The 1953 production of the Berlin plant HF, amounting to 250 units, is destined for USSR consumption. The Rudolstadt X-ray tube production valued at DM 3 million could be converted to transmitting tubes.

Hungary

There are two plants in Hungary worthy of consideration, the United Incadescent Lamp and Electrical Company "Tungsram" and the former Philips plant, both of which are located in Budapest.

d. Radio Relay Communications Equipment

During the last three years a Soviet-sponsored development of decimeter radio relay equipment has reached such proportions that the capabilities of the Soviet Union's military communications system may have been significantly increased. This type of equipment permits directional transmission at extremely high frequencies, with relay stations required at horizon distances. It thereby provides much greater security and freedom from hostile interference than does non-directional radio equipment.

Decimeter radio equipment is made in East Germany and in the USSR. In East Germany this equipment is made at the Sachsenwerk Radeberg factory, formerly a SAG plant which, in May 1953, was placed under the "Ministry of Post and Telecommunications."

The well-known measuring equipment firm Rhoda and Schwarz in Munich which gained experience in this field during the war and in the radio telephone project for Blockaded Berlin has contributed much to this Radeberg development and has equipped the laboratories with modern measuring instruments. _/

The decimeter equipments in the USSR are made at communications factories in Gorki and Leningrad. Both the USSR and East German factories work and coordinate their developments with the Decimeter Institute in Leningrad.

The importance of the plans of the Soviet rulers is illustrated by their intentions to put into operation a new plant of the HF Werk Oberschöneweide at Müggelsee for electronic microwave directional and radar equipment. _/ Two types, modifications of the World War II German types "Michael" and "Stuttgart," operate on wave lengths of 53 to 63 cm. and 20 to 28 cm., respectively. Sets manufactured include fixed and mobile versions; the latter consists of two complete transmitter-receiver sets mounted on a truck and is suitable for use at division headquarters or for intermediate points in a radio relay system. The fixed sets would be more appropriate for use at relatively immobile corps or higher headquarters. As early as 1951 the equipment was used in the Soviet Army manuevers in East Germany. Associated elements are made for use on stationary installations. Improved version of the decimeter equipment, RVG-902, is used with directional horns mounted on towers when used in stationary installations. _/

Approximately 2,000 sets of decimeter communications equipment have been produced in East Germany since 1948. Of these approximately 500 were of the "Michael" type, the remaining either the "Stuttgart" or improved versions. 21 of a later type of decimeter equipment, the RVG-903 with conical antennas, were made in 1951. "Mass production" of the decimeter equipment is planned for East Germany.

The following table indicates the total and probable production of decimeter equipment in East Germany:

Year	Types of Decimeter Equipment	Known Production	Indicated* Production
1949-1950	RDS-1, 2, 3, 4	50	500
1951	RDS-1, 2, 3, 4	42	500
	RDS-1-A (RVG-903)	21	
1952	RDS-1-B	338	350
	RDS-1, 2, 3, 4	-	400
1953	Improved type		1,000
1954	Improved type		1,500
1955	Improved type		1,800

From the information compiled on the tube industry and specific details on the production and distribution of the metal-ceramic UHF triode tubes, the USSR production of relay equipment is of about the smae magnitude as that of East Germany. It is predicted that the Soviets are concentrating on the fixed stations for the communications network since German production is maily for mobile installations. 75/

The development of the time pulse and phase modulation carrier systems has greatly expanded the potentialities of microwave systems. Production for testing and experimental links of both a 60 channel time pulse modulation system and other multi-channel systems have been under consideration. The Niiska Institute for the development of communications equipment for use by troops worked on a pulse modulation microwave link as early as 1950. Actually tactical or commercial use of this equipment is doubtful at this stage but will be a factor to consider by 1954, and maybe even in 1953. _/ Production for testing and experimental links of 60 channel time pulse modulation system was however started in 1952. Success in the development of better receivers, such as type: RVG-906, RVG-904, RVG-905, is apparent by the use of a RVG-905 unit in East Berlin for a television feeder line in December 1951. _/

The use of decimeter equipment directly affects the jamming vulnerabilities. If decimeter communications links are available to handle traffic that would normally require high frequency radio communications, the Soviet facilities, of course, are not nearly so susceptible to jamming. Furthermore, the Soviet high and even medium wave frequency facilities can be used to jam external and undesirable radio transmissions without disrupting the existing necessary communications network. Any expansion of radio link line-of-sight networks, therefore, has a significant bearing on the importance and potentialities the Soviets give to the counter-effects of both their and our own jamming activities. The use of the 400-500 megacycle, 24 channel radio link systems in Czechoslovakia; the indicated interest in USSR of constructing 250 relay stations between Moscow and Pepking; the need of 6,200 microwave towers from East Germany confirm this trend to increasing use of microwave and indicate the importance of the developments. 78/

The quantities of decimeter-link equipment now estimated to be on hand are capable of providing up to 400,000 circuit-miles of high-grade, relatively secure, and jam-free radio communications. This figure possibly is being augmented at the rate of about 200,000 circuit-miles per year. The scale of this program tends to indicate the Soviets are planning to equip their high-level military communications nets with radio link equipment. Due to its directional and high-frequency propogation characteristics, jamming efforts are practically ineffective. The Soviets would therefore feel free to employ their own jamming tactics against opposing military communications without fear of retaliatory repercussions

c. Civilian Radio Equipment

The production of civilian radio equipment represents about 26% of the total production of electronic equipment within the Soviet Bloc. Since about 11% is estimated to be applicable to essential domestic and industrial uses the remaining 15% is applicable to civilian radio usage, which productioh could undoubtedly be diverted to the military requirements. 79/

Despite a considerable expansion of the Soviet Bloc electronics industry, especially since 1948, the percentage of industry effort devoted to the manufacture of civilian radio and television receivers remains small. 80/

The estimated Production of civilian radio received in the Soviet Bloc for the years 1948 through 1951 is shown in the Table below is indicative of the effort allocated to the needs of the people. 81/

Estimated Production of Civilian Radio Receivers in the Soviet Bloc
1948-1951

Thousand Units

Country	1948 SW	1948 Non-SW	1949 SW	1949 Non-SW	1950 SW	1950 Non-SW	1951 SW	1951 Non-SW
USSR								
Tube receiver	391	31	400	90	75	416	62	450
Crystal rcver.	#	177	#	230	#	409	#	450
Total	391	208	400	320	75	825	62	900
Czechoslovakia	267	#	275	#	200	#	150	#
Hungary	6	18	13	38	25	75	28	83
Poland	1	#	2	#	3	#	4	#
Rumania	10	#	#	20	6	18	8	23
Bulgaria	#	##	#	#	#	#	75	#
East Germany	150	#	220	#	275	#	321	#
Total	825	226	910	358	584	918	648	1,006

*SW indicates receivers with short-wave reception.

The ability of the Soviet and East German Electronic Industry to use scarce material and critical highly skilled capabilities in the production of television receivers for evident purpose of propaganda confirms progress in the production of military electronics equipment. If the need arises this capability can be diverted into the production of electronic equipment of strategic importance. The small effort used in the production of television equipment is indicated by the number of receivers produced shown in the following table. 82/

Estimated Production of Civilian Television Receivers in the Soviet Bloc
1947-1951

Units

Country	1947	1948	1949	1950	1951	1947-51 Total
USSR	1,000	3,000	5,000	9,000	10,000	28,000
East Germany	0	0	0	0	29,000	29,000

f. Wire Telecommunications Equipment

This section is based on the following premises. First, telegraph manufacture is of minor importance, production-wise, and almost impossible to determine, while telephone instrument* production is more important production-wise, and more easily calculated. Secondly, production of allied telephone equipment, such as switchboards and telephone exchange equipment, is not a determining factor in measuring capability, since available information indicates that such equipment is produced only as needed, and not usually as a continuing product. This is especially true in the larger factories, where the really complex equipment is turned out. Therefore, telephone instrument equipment will be the index used to indicate Soviet Orbit capability in this field.

Statistics available do not permit a complete breakdown into military and non-military production within this category. Therefore, they shall be considered together and the industry treated as a whole.

Soviet Orbit Overall Production: In the Soviet Orbit, the wire telecommunication equipment industry is by itself, only a very small but important portion of the total electronic production of any one of the countries here considered, ranging from four per cent in Poland to about 10 per cent in Czechoslovakia. Total telephone instrument production for the orbit is estimated at from 500,000 to 1,000,000 instruments during 1952. Indications are that there were approximately 200,000 to 300,000 new subscribers during this period. It must be understood that many subscribers use large quantities of telephone instruments for private branch exchanges (P.B.X.'s) and therefore, as the exact quantity of production is not known, the larger estimate of 1,000,000 is used in this report and breakdowns of production follow. Indications are that approximately 44.7 per cent of the production of telephone equipment is within the USSR while the remainder is satellite production.

*Telephone instruments are defined as customary desk sets, wall telephones, and local battery telephones with magneto ringing.

By country, production can be broken down as follows: 83/

Albania	none	
Austria (Soviet Zone)	20,000	
Bulgaria	10,000	
Czechoslovakia	150,000	
Germany (Soviet Zone)	175,000	
Hungary	100,000	
Poland	28,000	
Rumania	50,000	
Satellite Total		553,000
USSR	450,000	
Grand Total		1,003,000 telephone instruments

Labor Force: A basic charasteristic of this industry is that telecommunication equipment is manufactured in radio and electronic products plants with a few notable exceptions. Even many of the largest producers of wire telecommunications equipment are large producers of radio receivers as well. Therefore, based on current information it is impossible to state the number of employees actually devoted to production of this type of equipment.

Expansion of the wire telecommunications industry would be readily accomplished by the conversion of other types of electronic production. Since most wire telecommunication equipment plants produce other electronic equipment as well, production expansion by conversion of existing facilities would be relatively easy. Available information is not sufficient to venture any firm figures on amount of expansion possible by this means.

Carrier equipment used in long distance wire and cable routes makes it possible to have many conversations on a wire or radio circuit.

In view of the fragmentary information available on Soviet domestic manufacture and imports of carrier equipment, no accurate estimate of actual production capacity is possible.

Information on Soviet orders to East German manufactures, may serve as a guide in determining types and extent of equipment presently produced.

USSR Orders for Carrier Equipment from East Germany 84/

Year	Plant	Location	Number of sets	Model
1949	OSW Berlin	Berlin	20	A84L
1949	Stem Radio	Rochlity	40	TFC
1949-50	Fernmeldewerk	Lipzig	4000	TFC
1951	Fernmeldewerk	Bontzen	5	ME8
1951	Fernmeldewerk	Lipzig	50	ME8ZV
1951	Fernmeldewerk	Lipzig	200	TFC
1949-51	Total		4319	

There is undoubtedly current production of this equipment in the USSR. However, other than the reported production of the communication plant, Irkutsk is supposed to have been making two telephone carrier equipments per month in 1949. No details are known.

Production of telephone, telegraph and associated wire line equipment is in good shape throughout the Orbit, and the present production can undoubtedly be stepped up if the necessity for more equipment arises. The actual amount of raw material that goes into the production of telephone instruments and associated equipment is small in relation to the amount used by the wire and cable industry for connecting lines. Where local shortages occur, substitutions can usually be made to keep production going.

g. Wire and Cable

In the postwar period, wire and cable plants of the Orbit have been brought to a high level of technical excellence and have been greatly expanded. Not only have new plants been set up, but older plants have received new machinery. Two of the largest plants have been making particular efforts to advance the technology of the entire industry by the organization of development and research facilities.

To indicate the production of wire and cable in the Orbit, the following table shows the amount of copper used per country with the number of miles of single #16 gauge wire that could be produced from this amount of copper. Many sizes of wire are used in telephone and telegraph open wire and cable and a tabulation of quantities of each size is impossible. The #16 gauge can be taken as an average and is used as an illustration only. This table also gives some other pertinent estimated figures on manpower and costs by country for this industry figured for one year, 1951. (For table, see following page.)

It is not possible to separate the production of telephone wire and electric cable in an accurate manner.

To stretch the amount of wire that can be made from available copper, aluminum is added to many mixes. When this aluminum is combined with the copper, the poundage of the product is referred to as copper content. The Orbit used approximately 106,000 metric tons of copper content material in the wire and cable industry for 1951. The actual amount of copper in this quantity of copper content wire would be 84,000 metric tons. 85/

It has been reported that the Satellite countries are now trying to use aluminum wire (without any copper content) in the manufacture of Motors and Transformers. If this is successful, it will help stretch the quantity of copper.

Approximately 20% of the wire and cable used is imported. Great efforts are made by the Orbit throughout the entire world to buy copper for import. Reports indicate that there is sufficient raw copper in the USSR to meet its present production for wire and cable, but this is not true in the Satellites where raw copper is in short supply. The Orbit produces 268,325 metric tons of raw copper and imports an estimated 80,000 metric tons, making a total of 348,325 tons. The wire and cable industry uses 84,000 metric tons of this total leaving 264,325 tons for other uses. These other uses are also important and include motors, generators, switchgear, aircraft, automotive, etc. If the necessity arose to increase the output of the wire and cable industry, copper would have to be taken from some other consumer, and if the end use of the wire was of a high enough priority, it is felt that the plant production could be greatly increased. 86/

Collected 1951 Input Requirements for the Soviet Bloc

Wire and Cable Industry and their Cost in 1951 U.S. Dollars [87]

Country	Metric Tons Copper	Metric Tons Aluminum	Metric Tons Lead	1,000 Manhours	Cost of Input for entire industry Production in 1951 U.S. Dollars	Million Miles of #16 wire that could be made from Copper	Direct Labor Force
USSR	52,700	4,650	9,486	40,000	118,278,000	2.808	20,000
Czechoslovakia	9,000	1,750	1,620	10,000	26,227,000	.479	5,000
East Germany	14,242	2,279	2,564	17,000	43,355,000	.759	8,500
Hungary	3,000	1,500	540	7,200	15,996,000	.160	3,600
Others	5,076	812	014	8,000	18,471,000	.271	4,000
Bloc Total	84,018	10,991	15,124	82,200	222,327,000	4.477	41,100

2. Imports

Prior to World War II, USSR imports of communications equipment were small, amounting in the late 1930's to some $5,000,000 annually, or about 2% of total Soviet imports. The principal countries from which equipment was received were the U.S., Great Britain and Germany. 88/ Substantial quantities of telephone equipment were imported from Sweden. The USSR has always been dependent on imports of critical electrical and electronic test equipment, although this dependence on the Western world is rapidly being decreased.

During World War II, USSR imports of communications equipment greatly exceeded prewar imports. These imports included large quantities of tubes, components and end equipment.

The U.S., under lend lease, became the predominant source of critical and technical equipment. Between June 1941 and December 1945, $216,273,000 of equipment was shipped to the USSR. Some of the important items are noted in the following table:

Type of Equipment	Amount
Radio measuring & testing	#3,174,000
Field telephone wire	956,688 miles
Radio transmitter (1 kw & over)	30 sets
Radio transmitter tubes	345,027 tubes

The import of electronic equipment has been of vital assistance to the Soviet communications program. To a limited extent the quantity of imported electronic equipment has been hampered by the currency restrictions of available hard currencies in the Soviet Bloc, and Western Export Trade Restrictions. The currency seems to be available for critical electronic requirements, and export restrictions have but limited effect on critical Soviet needs and strategic items, as indirect means for importing such items on export control list have been used.

Although the Bloc is not dependent on imports for transmitter equipment and tubes, there have been important deliveries of this equipment. Known shipments came from France, Belgium, Switzerland and Sweden. It is difficult to determine the amount of the imports of the various types of electronic equipment; however, for the purposes of this study, the volume of the traffic and the significance of the imports can be determined. The amount of imports, such as transmitters, electron tubes, telegraph and telephone equipment, has been calculated on the basis of known shipments during the last part of 1950 and during the year 1951, value of these known shipments is $6 million. The estimated total for 1951 imports of electronic equipment is $14 million. This is about 2% of the Bloc production of electronic equipment, although it is of much greater importance than indicated by this percentage. 89/ 90/

In addition to shipments from the U.S., substantial amounts were received from Canada and the United Kingdom, though quantities of imports of electronic equipment have been relatively light since the war. The USSR is now relying on the Satellites productive resources to supply part of its military and other needs for communications equipment. Small quantities of quality electronic equipment for development and research programs are continually imported by the Bloc. In addition to electronics equipment the Satellites, in the past have imported valuable scientific instruments and test equipment from the U.S. and European firms. 91/

There are cases where the USSR has imported complicated equipment and then manufactured copies, as their industrial capabilities permitted. An example is the production of the SCR-584 control radar which was furnished the USSR during World War II by the U.S. Another example is the manufacture of vacuum tube voltmeters copied from the design of the Radio Corporation of America.

While the Bloc as a whole imports relatively little end equipment, tubes and components, significant quantities of materials required in the manufacture of tubes and components are imported. These materials include capacitor paper, molybdenum and tungsten wire and alloys of these metals, nickel cathode sleeves, mica, and certain machines used in the manufacture of tubes and components, such as exhaust machines. Diamond dies, in demand for drawing wire, are supplied from western sources. Needless to say, present international agreements do limit the exports of western nations, but the amount of clandestine trade is relatively high, and the volume of some of these items is so small that they can be transported in a diplomatic pouch; diamonds for dies have been shipped to the Bloc in this way. Tonnage requirements of refractory metal wires are small enough to allow secret shipping in effective quantities. Though capacitor paper is somewhat more bulky, there is evidence of illegal shipment of this commodity. The interdiction of all imports to the Bloc would curtail the flow of these strategic materials and cause the Bloc to to exhaust their stockpiles while their domestic capacity was increased to supply the additional demand. As much as 50% of some of the aforementioned items are from western sources.

In some cases there is no shortage of the basic raw materials used in the manufacture of semi-finished commodities which the Bloc actually imports. A deficiency of technical ability or production facilities may limit production and necessitate the import of such items. For instance, the Bloc is very well supplied with tungsten ore, but is unable to fabricate tungsten wire of electronic grades in sufficient quantities to satisfy its needs.

Copper and copper products are scarce in the Bloc, and shortages in the Satellites have been known to limit the production of wire, cable, and electrical equipment. The present level of imports suggest that the Soviet Bloc may be dependent on Western sources for 20% of their wire, cable, and copper products. 92/

3. Distribution and Allocation of Equipment Resources

The military requirements are given first priority in the distribution and allocation of electronic equipment resources. It is impossible to determine the numbers of the different types of the various electronic equipments allocated to the various consumers or even the consumer categories. However, a pattern has been determined which is very valuable when considering this aspect of the problem. This end use consumer pattern is as follows: 93/

Category	Percentage of the total Value
Civilian Radios, Television sets, and replacements	15%
Essential Domestic Services and Industrial Uses	11
Military Electronic Equipment	74

Military Electronic Breakdown:

	%
Microwave Radar	26
Other Radar	21
Military Radio	23
Miscellaneous Military	4

The above consumer pattern is based on the distribution of vacuum tubes, therefore, the actual output and distribution of equipments will vary by number, weight, or value from these percentages. For an overall consideration the tube end use pattern is the best available, since by definition, electronic equipments are products employing tubes, and the ratio of total tube value to total equipment value is relatively fixed.

The burden of supplying the Soviet Navy with communications equipment is comparatively light as contrasted to the needs of the Army or the Air Force. The same principle applies in the Satellites. The Navy of the USSR as far as can be determined (judging by radar installations, for example) seems to be receiving its proportionate share of modern electronic equipment. 94/

The amount of signal equipment in line and support divisions of the Soviet Army is illustrative of Army requirements for signal equipment. These requirements are given on the following page.

S-E-C-R-E-T

Soviet Army Signal Equipment Requirements for Line and Support Divisions 95/

Type of Equipment	Number of Equipments: Present Troop Strength *	Number of Equipments: Double Present Troop Strength **
Radio	47,090	92,895
Switchboard	23,060	43,987
Telephone	136,675	253,752
Telegraph	1,746	3,014
Teleprints	976	1,684
Radio Truck	1,880	3,215
Radio Receivers	777	1,213
Wire (in miles)	141,891	272,569

* Approximate number of different types of signal equipment presently in the hands of the troops.

** Approximate signal equipment requirements if the troop strength should be doubled.

S-E-C-R-E-T

C. Electric Power

Radio transmission depends upon electricity as its source of energy. The total amount of electric energy consumed for all rapid communications purposes in any one of the Soviet Orbit countries represents a very small percentage of the total amount produced in that country or available to it.

In European USSR, including the Caucasus, electrical energy is generally available from central station sources. This is possibly not true of the eastern portions of Archangel and the Murmansk Peninsula. There is no completely integrated transmission network in European USSR. The individual networks radiate from or serve most of the larger cities. In Asiatic USSR, central station power is available along the Trans-Siberian Railway and its branches, and in the Kirghiz and Tadzhik SSR. In the interior of Central Asia and in the vast area east of the Urals and north of about latitude 60^{0} north, central station service is the exception rather than the rule. In the areas without central station supply, resort must be made to more laborious and inefficient methods of producing power. Apparently the Soviet Union uses in such cases internal combustion or steam engines, wind driven generators small hydro generators and batteries to supply radio facilities. In the artic regions where transport of fuel and machinery is difficult, the problem of assuring reliable rapid communications, services could become vexing under sudden heavy demand conditions.

In Communist China, electrical energy is generally available in Manchuria, except possibly in the extreme northern and western portions. It is also available along the whole coast line and in some of the larger inland cities. Outside of Manchuria there are no transmission networks of any magnitude, and in the larger interior regions, including Inner and Outer Mongolia and Sinkiang, reliance must be had on one or more of the sources mentioned under the USSR.

In the European Orbit countries there are no large regions without central station power service 96/

D. <u>The Present Orbit Communications Manpower Resources</u>

With a combined population of over 800 million, the Soviet Orbit possesses an abundance of manpower, of which much is unskilled. While a considerable number of unskilled workers are consumed in rapid communications construction and maintenance operations, the installation, operation and technical maintenance of the rapid communication resources of the Orbit require appreciable numbers of skilled laborers, technicians, engineers, and some scientists. These skilled workers are believed to be in short supply generally. Essentially, this shortage stems from war losses and from inadequacies of training facilities. Against this shortage is an increasing demand for these types to accelerate the fulfillment of stepped-up plans for improving the industrial and military power of the Orbit. By using Germans as consultants and by graduating large numbers of students, the USSR in 1949-1950 began to overcome the shortage of skilled workers.

Since V-J Day, the Soviets have placed great emphasis upon improving the scientific and technical qualifications and increasing the number of their electronics personnel. Research scientists have been placed in a privileged class and public recognition of outstanding accomplishments has been lavished upon them in the forms of financial rewards and honor recognitions. To obtain more research, development and operation personnel, emphasis has been placed on technical training in universities, engineering schools, special technical institutions, and on correspondence courses. At present the Soviet system has tended to produce excellent research scientists and fairly good technical workers, although all electronic industries, including the U.S., are "short" of experienced manpower needed to reduce research ideas to practice. This particular problem in the USSR seems to have improved greatly since 1948.

[redacted] 25X1

The manpower observations on the USSR apply generally to the European Orbit countries except Albania, where skilled personnel is very scarce. China has relatively few engineers and scientists with electronic skills and would encounter difficulty in rapidly expanding training facilities without foreign assistance. 97/

The training of manpower in the field of communications is estimated as follows: 98/

Communications:

Number of graduates - Electrical Engineers - from universities of college type institutes	4687
Number of graduates of technical schools, below college level with 3 to 5 years courses; per year	10,000

1. Manufacturing:

In 1952 [redacted] 25X1
employment in enterprises associated with the Soviet administration controlling tubes, lamps, and related products had reached a total of
This figure, which may be compared with 51,545 for the U.S. in 1947, is appreciably higher than indicated by earlier estimates, and tends to confirm the expansion trend after 1950. 99/ 100/

The total number of employees in the Bloc electronics and telecommunications manufacturing industries is estimated as 292,000 for 1951. Of this number 210,000 were in the electronics industry and 80,000 were in telephone and telegraph manufacturing. The manpower of the electronic industry in the satellites amounts to 40% of that of USSR. The estimates for 1952 have been increased for the electronics industry based on recent information showing large increases in electron tube production. At the end of 1952 the total Bloc employees in electronics and telecommunications manufacturing is estimated to be 372,000.

A small core of top scientists in the USSR are thought able to do original research in some highly specialized electronics fields and adapt the results of their work. This may be one of the key manpower factors for successful prosecution of long-term electromagnetic warfare. It is notable that military representatives are frequently associated with electronics manufacturing, an example being Admiral Berg of the Moskva Radar Institute. It is believed that the flow of information from manufacturing plant to field force is well-provided.

In the several electronic fields, trained Orbit industrial manpower is probably adequate. Higher technical schools and universities have departments devoted to electronics, some of which are staffed by industrial personnel. Thus, liaison between training establishment and factory is effected. Within most large Soviet electronics plants, in-training schools have been set up and a large proportion of workers attend classes after work hours.

2. Operating:

In 1952 there were an estimated 600 thousand persons engaged in the Communication industry of the USSR. It is planned to expand this figure to 760 thousand by 1957. These figures are exclusive of military personnel. The planned rate of expansion in skilled and technical personnel is even more rapid. Any increased electromagnetic warfare activity on the part of the Orbit would involve mainly the radio circuit operator and the radio transmitter attendant types of trained personnel; the training time required to increase the numbers of these types would amount to less than one year, with much less time for radio amateurs, who are presumed to be partly trained.

The postwar shortage of operating and maintenance personnel continues for servicing complex military electronic equipment utilizing very high and ultra high frequencies. The continuously stepped up in-service educational program may largely overcome this deficiency within a few years. A large exploitable manpower supply is available in the military services and in itself is not a limiting factor in expediting an electromagnetic warfare program.

The radio amateur group is an important source of trained or partly trained manpower. The number in this group today is not known. Each Orbit country has a group of amateurs who seemingly are given directed encouragement by their governments. As early as 1924 the Soviet Union numbered several hundred thousand amateurs within its borders. 101/ The number is probably much larger today.

E. Modernity of Applied Techniques and Technologies.

1. Techniques, Procedures and Technologies.

a. Wire Communications

The two outstanding deficiences in the telephone long line system are first, the bulk of the outside plant consists of open wire pole-line, and secondly the limited use of multi-channel carrier telephony which is due to the inherent limitation of open wire line, as well as the unavailability of broad-band carrier equipment. A further impediment to increased application of carrier equipment is the fact that a considerable fraction of the conductors are steel rather than copper, not merely because of material shortages but also because of mechanical stress caused by climatic conditions.

As regards inside telephone plant, the Soviet automatic step-by-step dialing system provides reliable and rapid services; it is old fashioned only in regard to its sturdiness and bulk. The need for dial systems is small in proportion to the population, since the number of subscribers is not large and for the same reason there is little need for long distance dialing service. Modern trunking practices are found in the switching arrangements of metropolitian centers. On the whole, telephone equipment is diverse rather than standarized, and maintenance is thus agitated. Telegraph carrier equipment is widely used on long distance circuits as the most practicable solution to the limitations of the open wire lines, and of existing voice-frequency repeater stations.

b. Radio Communications

In the field of high frequency long range radio communication most Soviet techniques are advanced. Antenna arrays of great power gain andmaximum tuning flexibility are in wide use. Extreme magnitudes of radiated powers are obtained by carefully designed arrays of properly phased, fed radiators. For many years Soviet high power transmitter tubes have provided reliable performance. Good facsimilie transmission is well established, and tape telegraphy transmission speeds of 1000 letters per minute are routine.

Standard low power radio equipment is of widely varying age and of many makes. Soviet-produced models of the US Army radio set SCR-284 are in quantity use for short range civil communication applications along with much earlier Soviet designs.

Until recently frequency-shift keying or single sideband methods had rarely been used.

Although the Soviets are familiar with the broad-band multi-channel advantages available from radio relay links (above 30 MCs), there is no evidence of current usage in the communication system.

c. Technology Development

The Soviet Orbit has placed particular emphasis on raising its technological and scientific level in the field of electronics to one more compatiable with western standards. Orbit electronics technology has advanced to a level equal to that of the west in some particular phases of the field, but in others it has shown little imagination or initiative.

After World War II the Soviet Orbit copied imported modern equipment. Technical personnel, trade literature, and in particular, the better authorative text and specifications used in western countries were exploited to the fullest extent thus closing the technological gap in the broad field of electronics some three to five years. Lend-Lease equipment and technicians from the U.S. and other allied countries supplied under the war program advanced technical know-how that was lacking by the Soviets. The Soviet Union exploited the electronic resources of such countries as East Germany, Hungary, and Czechoslovakia, which have been generally regarded as having a high level of technological competence in the electronics field. This total resource is assumed to be in a state of continuing exploitation to serve the growing needs of the Orbit.102/

The rapid advances in Soviet technology were not solely the result of Soviet abilities, but to the contrary, they were the sum total of "borrowed" talent from the Satellites and western countries. It is possible that the Soviet rate of technological development will not be as rapid as in the past, nor the rate such as to continue to close the existing gap appreciably, except in specialized phases of the electronics field in which they devote a particular interest.

d. Production

Standardization of equipment and operations is the key to communication efficiency, flexibility, economy, and complete integration. This, the Soviet Orbit does not fully enjoy. With the possible exception of East Germany, Hungary and Czechoslovakia, the Orbit countries including the USSR have over the years imported much of their communications equipment, techniques, and technologies, partly from Germany and Czechoslovakia and partly from many countries of the Western World and Japan. Much of this importation continues, and apparently will continue for many years to come. The various equipments are incompatible therefore difficulties must necessarily exist in system integration, maintenance, and maximum flexibility of operations.

It is difficult to determine the modernity of present Soviet production methods, but it is known they have stressed increased productivity through technical developments. Production has been increased by improvements in methods and machines, combined with more skilled, better trained manpower motivated by high worker incentives to produce greater outputs. Foreign engineering talent, principally German, has been exploited to improve post war Soviet techniques, which, by Western standards, were inefficient and labor consuming. It is believed that during the post war readjustment period, Soviet industrial methods were concerned with full employment rather than efficient production. Now the Soviets seem to be directing their efforts toward high worker productivity, conservation of strategic materials, simplification of design, and manufacture of a product susceptable to mass automatic processes.

During and before the war the Soviets used United States technical assistance, and since the war have exploited the German industry and its Engineers. Under the war time program, the Soviets were able to learn considerable about our methods of quantity production of quality electronic products. For example, USSR employs current U.S. manufacturing methods in the production of fixed paper dielectric capacitors, while they use a German "Bosch" method in producing DC metalized paper capacitors; the Soviets also use production techniques similar to those employed in the U.S. in the manufacturer of capacitors used in power-factor applications. Soviet production methods are copied from those used in more advance countries, advancing them in strides that would not be possible under normal conditions. The improvements of the standard of their technology and production methods to the present are reflected in the greatly increased output of the electronic industry.

F. Trends

General

Beginning with the First Five-Year Plan in 1928, and continuing in all subsequent plans, first priority was given to the installation of rapid communication facilities, second priority to the provision of underground cables to link key cities with Moscow, third to the extension of overhead lines, fourth to increase the number and power of radio stations to improve the basic network, and fifth to the extension of radiobroadcasting facilities. A sixth item appeared in the 1946-50 Plan, the expansion of facilities in rural and remote areas. There is evidence that the USSR has been accomplishing all of these intentions with the probable exception of the underground cables connecting all key cities with Moscow. Apparently the Soviet Union was neither able to manufacture nor import sufficient cable to achieve that end. In the interim the Soviet Union took full advantage of the steady progress being made in the radio art to overcome its serious wire line deficiencies. Prior to World War II, the principle was applied in the adaptation of radio to the basic telephone and telegraph system that the particular medium of transmission should be used which geographically or politically best suited a given set of conditions. There was no attempt to employ either the radio medium or the wire medium in all cases. Radio was scheduled to be the sole means in many remote areas where under normal conditions the employment of wire would be economically inadvisable. On the other hand, radio facilities were to parallel in some cases existing wired trunk lines. Where there is a choice of media (as between radio, and wire and micro-wave radio) over which to route traffic, the Soviets would choose wire or micro-wave radio for communication security reasons. In fact when the Soviets saw World War II coming they shifted much of their official classified state traffic from radio to wire. This practice apparently continued through the war years and it is believed the practice continues today. This means, that where a choice of media exists, communication security would dictate that the wire or micro-wave radio medium be used for strategic traffic and the radio for innocuous public correspondence as far as practicable. It is believed that these general Soviet trends permeate the entire Orbit. 103/

1. **Post World War II to date**

The trends in the development and use of Soviet Orbit rapid communications service have been motivated by the needs of the state primarily and by those of the consuming public secondarily. In the immediate post World War II period, effort was concentrated on the restoration of those facilities destroyed or devastated by the war. It is estimated that this restoration period, more or less, ended about 1949, with the exception of East Germany and China. In East Germany the Soviet Union removed as "reparations" much of the worthwhile rapid communications plant that remained intact. Today East Germany is still in the process of restoration, though some new facilities are being provided. In Communist China, the USSR removed a good portion of the rapid communications facilities in Manchuria, which had been installed or improved during Japanese occupation. By 1951 it is thought that Communist China, except for Manchuria, had been able to reach 1937-1938 facilities levels. It is not believed that Manchuria has yet attained the peak level of the Japanese occupation period. Apart from these exceptions it is quite clear that the Soviet Orbit has, since about 1949, been able to increase the capacity of existing plant, to extend its plant to virgin territory, and to apply new world techniques and technologies created during and since World War II.

a. Wire Facilities

In the USSR several long wire lines of strategic significance have apparently been constructed in recent years or are under construction in the direction of the Arctic and in the Far East. These are shown on the map in Appendix B.

In the European USSR the land-line from Kirov to Vorkuta, latitude 67° North, longitude 64° East, via Kotlas and Ukhta, covers a distance of some 1400 kilometers. Three other land lines, running generally eastward, connect Kotlas with Vologda, Konosha and Obozerskaya, covering a total distance of approximately 1200 kilometers. The latter two are unconfirmed. Another unconfirmed line **extends** from Ukhta, north along longitude 54° East, to Nikittsy, latitude 68° North, on Pechorskaya Guba, approximately 500 kilometers. Still another unconfirmed land-line extends north from Solikansk to Ust'Shchugo, longitude 64° North, latitude 57° East, a distance of some 500 kilometers. 104/ 105/

Submarine cables are shown in the Barents Sea from Polyarnyy to Archangel via Yokan'ga, some 700 kilometers, and across the White Sea from Pyalitsa to Intsy, a distance of about 50 kilometers. 106/

A coaxial line is reported under construction between Moscow and Leningrad via Kalinin, a distance of some 600 kilometers. The Moscow-Kalinin section of some 200 kilometers was reportedly completed in April 1952. 107/

In Asiatic USSR, one land-line extends from Krasnoyarsk to Dudinka at about latitude 70° North and longitude 86° East, generally following the route of the Yenisei River, a distance of some 1,500 kilometers. 108/

Recent reports and maps show wire construction of land-lines in the vicinity of Yakutsk. Two lines go north and northeast from Yakutsk to Ust'Aldan and to Krest-Khal'-Dzhay, respectively, and a third line extends from Suntar to Vilyuysk. These lines range in length from 180 to 280 kilometers. In the Far East, the Yakutsk-to-Magadan line has been recently extended to Khonu on the Indiginka River, via Ust'Srednikan on the Kolyma River, approximately 1000 kilometers. Another significant extended line is that from Magadan to Klyuchi on the Kamchatka Peninsula. This line goes north from Magadan to approximately 62° North latitude, crosses the Penzhinskaya Guba and then turns south on the Peninsula to Khayryuzovo and Petropavlovsk and thence to Klyuchi, approximately 2500 kilometers. Still another line extends from Yakutsk south and east to Nikolayevsk via Udskoye, a distance of some 1500 kilometers. 109/

On Sakhalin Island, the wire line from Moskal'vo south to Pilevo along the western coast has been extended to Kholmsk, thence east to Korsakov, and north along the eastern coast to Okha, virtually encircling the island 110/ Approximately 1800 kilometers)

The island is connected to the mainland by three submarine cables: from De-Kasti to Alexandrovsk, from Sovietskaya Gavan to Orlovo 111/, and from Vladivostok to Orlovo. 112/ The first two are relatively short; the third, however, is approximately 1,200 kilometers in length. Sakhalin is connected with Japan by two cables between Korsakov and Sarufutsu (not operating). 113/

These developments show a trend towards pushing out with wire lines to the uncovered North and East.

In 1948 construction was underway in the USSR on some 40 thousand miles of wire line routes. Priority has been given to routes serving important areas. The use of multi-channel carrier systems on existing wire lines as well as some of the newer ones has greatly increased the traffic handling capacity of the basic systems. 114/

The new Soviet Five-Year Plan (1951-1955) gives the following language pertinent to this sub-section. One reference reads: "....To insure the further development of means of communication; to increase during the Five-Year Plan, the length of intercity telephone lines by not less than 100 percent...." Another reads: "....To increase the capacity of telephone exchanges in cities during the Five-Year Plan by 30 to 35 percent...." Specific references were not made to telegraphy, nor to what the word "lines" means. It probably means wire lines but could include radio "lines." 115/

Some numerical notion of the post-war growth of USSR basic communications services may be useful. But since the wire and radio traffic figures cannot be separated because the two media are integrated, the following figures include both. The number of interurban and international conversations in 1946 is estimated at 80 million and in 1951, some 132,000,000. The number of telephone subscribers is estimated at 721 thousand in 1945 and 1.5 million in 1951. This is in spite of the fact that in 1949 it was reported that telephones were not widely used by the public and that private telephones were practically non-existent. The number of telegrams handled in 1946 is estimated at 176 million and in 1951 some 283.5 million. 116/

Appendix J gives an indication of the extent to which wire lines are being utilized to provide a "closed circuit" mass aural radiobroadcasting reception base. The total number of speakers installed is believed to have increased from approximately 6 million in 1946 to 11.6 million in 1952.

Appendix J shows the magnitude of this development and the rate at which the system is being extended in the Soviet Union. The essential purpose here is to bring the mass aural radio medium into the far flung villages and settlements in the Soviet Union, to enhance group listening, and either to insure "closed circuit" security or to extend listening facilities at cheaper cost. In one sense this development is a reversion from the radio medium to the wire medium to the extent that local distribution does not depend upon the radio medium. This is partly true of the cities in which the broadcasting transmitting studios are located. Urban, suburban, and in some cases rural areas are served by wire directly from the studio itself. Hence, with only the long distance links in question, a mass aural broadcasting system can be operated without the use of the radio medium. Where the long distance links can be provided through the wire medium, dependence on the radio medium is eliminated altogether. 117/

As for China, some progress has been made since World War II in theconstruction and reconstruction of wire line facilities. It is estimated that the telegraph line length rose from 50 thousand kilometers in 1946 to 133 thousand in 1952. For telephone lines, the length rose from 327 thousand kilometers in 1947 to 435 thousand in 1952. 118/

Since the inception of the Communist Chinese government in 1949, it is reported that long distance lines have been restored or constructed between a number of important cities including those between Peking and Nanning, between Shanghai and Shacheng, Shanghai and Mohien, Shanghai and Fengtai, Shanghai and Luhsieu, Tientsin and Kunming, and Tientsin and Sining, among others. In February, 1951 it is reported that work was begun to connect by telegraph line Lanchou in Kansu Province with Roch'eng on the Sino-Soviet border, a distance of over 2,000 kilometers. 119/ See map in Appendix B.

There is evidence that Communist China, in addition to extending its wire line facilities, has been increasing the traffic carrying capacity of its main lines and the density of its local wire line services in the larger cities. 120/

Appendix J shows that Communist China has embarked on a plan to employ the wire-diffusion technique in connection with the development of a "closed circuit" reception base for mass aural radiobroadcasting.

In the European Orbit countries with the exception of Albania, extensive reconstruction and construction work has taken place since the end of World War II on wire lines. Old lines have been repaired and/or improved. Traffic carrying capacities have been increased, some direct, official connections to Moscow and between Orbit countries have been established. Albania has done little to improve the basic system. It is slowly increasing the number of telephone circuits to the remote areas but there is no indication of widescale plans for modernization of the system. The wire-diffusion technique, in consonance with the Kremlin pattern, got underway about 1951. 121, 122/ In Bulgaria a gradual expansion of the wire network has been taking place in order to provide service in rural areas. The reported installation of automatic and semi-automatic telephone exchanges and the expansion of exchange capacity seems to indicate some progress has been made in modernization of urban facilities. 123/ In Czechoslovakia post war emphasis has been placed on bringing existing facilities up to date. Dial telephones and automatic teletypewriter techniques have been increasingly applied. Micro-wave radio relay circuits have been introduced. 124/

In East Austria the telephone wire system has been undergoing a change from manual to dial operation. Construction of coaxial cable in Western Austria has recently been started and is to be or has been extended into East Austria. The Austrian government hopes to be able to introduce long-distance dialing when these coaxial facilities are completed. The number of teletypewriters in the telegraph system have been increasing. 125/ In East Germany, the main emphasis as to wire facilities has been the restoration of the facilities confiscated by the Soviet Union mentioned previously and the expansion of pre-war plant. Part of the restoration has involved the introduction of micro-wave radio links into the basic wire line system. The use of the teletypewriter has been increasing. 126/ In Poland there has been extensive reconstruction of wire facilities and an expansion of what was available prior to the war. Progress in the integration of the wire facilities with the radio continued during the post war period. 127/ In Hungary, post war reconstruction has restored, expanded, and modernized the prewar system. New installations include four international carrier frequency cables, automatic telephone exchanges in major cities, extension of lines into villages and towns, and the construction of additional underground cables. 128/ In Rumania, reconstruction and new construction of wire line facilities has been taking place since the end of the war, particularly in and around Ploesti and Bucharest. Some facilities have been dispersed as a security measure. Additional cross-country lines are being installed by Soviet military personnel. Private telephones are being taken over for use by the government and military as necessary. 129/

One common development in the post war era in the European Orbit countries has been the wire diffusion technique. The growth and extent of this Kremlin pattern is shown in Appendix J.

b. Radio Facilities

In the Soviet Union the employment of the radio resource since the end of World War II has increased interms of the number of transmitters, the power of transmitters, their uses, and their service area.

In the Soviet basic system the number of radio stations was reported as 1,389 in 1941 and as 1,492 in 1951. But these figures do not include a considerable number of lower-powered radio stations serving communities which have no other means of rapid communications. One Soviet report states that during the 1947 elections some 4,750 radio stations were in operation, 1,500 of which had been newly rehabilitated. It is not known to what extent if any radio stations had been "borrowed" from other services for those election purposes.

One development of great strategic significance is the possible Soviet employment of the micro-wave technique. No solid evidence exists of the actual employment of micro-wave radio systems as an extension of, as a supplement to, or as a replacement for either the wire or radio (below 30,000 kilocycles) media in the basic system. As indicated later, however, micro-wave radio equipment has been in production for several years. [redacted] 25X1

25X1

25X1

Such a reality would have profound implications for electromagnetic warfare, communication security, the supply of long distance radio channels below 30,000 kilocycles, and the economics of Soviet basic rapid communications. 130/

The number and power of Soviet mass aural radio-broadcasting stations have both increased since the war, though the number of stations, in spite of the powers employed, seemingly are wholly inadequate to furnish a serviceable radio transmission base for so large a country. Part of this deficiency is apparently being met by resort to the use of the wire line through the rapid build up of wire diffusion loudspeaker networks. 131/

Specifics on the trends in power of other Soviet radio transmitters are fragmentary. This is particularly true of stations in the basic system where higher power is likely to be employed to cover long distances reliably and consistently. As to mass aural broadcasting transmitting stations, Appendix E shows the power of each of the transmitters employed in the more important stations of that service. The new Soviet Five-Year Plan (1951-1955) includes the statement "....to considerably increase the power of broadcasting stations." 132/ The Appendix lists one 500-kilowatt transmitter employed in the Moscow area. Several transmitters of power in excess of 500 kilowatts have been reported. One of these is known as "Goliath." This was a German transmitter used during the war for submarine communications. It was originally rated at 1,000 kilowatts and believed to operate between 15 and 60 kilocycles. It is now thought to be in use for submarine communications. 133/

25X1

[redacted]

It must be assumed, even in the absence of concrete evidence that the Soviet Union has been proceeding on the development and use of strategically important techniques developed during and since World War II. Some of these bear mention. The new Five-Year Plan (1951-1955) alludes to frequencies above 30,000 kilocycles the use of which could have importance as to dependence on frequencies below that figure in the statement".....To develop the work as regards the incorporation of ultra-short wave broadcasting and of the radio relay network...." This statement does not specifically include the use of such frequencies for aircraft communication and radionavigation, but the general techology is applicable for these purposes. 136/ Another revelation of strategic importance is the accumulating evidence on the Soviet development of a low frequency radio navigation system similar to Loran used by the US today, which may service both aviation and shipping. 137/

The fact that some use has been made of FM radio and that television stations now operate in at least three cities indicates a beginning in the use of very high frequencies (VHF). Moreover, it is known that the Soviets have at their disposal decimeter equipment developed by the Germans. It is believed that VHF type of equipment is now being used in aeronautical communications to some extent. It is believed that the Soviet Union is now engaged in an active program to provide its armed forces with radio and radar-jamming facilities. Although there exists a dearth of definite intelligence in this field, the Soviets have been afforded ample opportunity to become acquainted with German jamming and anti-jamming equipment and techniques.

Mention has been made previously of the improvement in engineering design. A lively interest in the very low frequencies for shore stations to be used in naval service is evident. Receivers are available down to 12 kilocycles and transmitters down to at least 15 kilocycles are also available. This could provide the Soviet improved frequency flexibility. [redacted] 25X1 There is no good evidence of their current use of frequencies below 15 kilocycles.

A trend to the use of the frequencies above 27 megacycles for short-range tactical communications since World War II is very apparent. This would relieve the congestion of the lower frequencies as well as increasing Soviet security for tactical traffic. Equipment is now being widely introduced in the 100-150 Mcs band to supplement their 27-32 Mcs and possibly other VHF band equipment. The decimeter equipment could be applied to shipboard use, but no such application has been detected. The use of infra-red would also provide similar relief to the lower frequencies.

Use of secure high-speed communications such as the German Marine "Kurier" at frequencies below 30 megacycles should be no surprise. We have no evidence of such Soviet usage, although our current probability of finding out about Soviet work on such equipment or use of such techniques is almost zero.

More detailed discussion of these matters may be found in ONI Serial F-26-3.

[redacted] 25X1

Radio equipment manufactured since World War II is very definitely not crude. Two of the newer radios widely used in the Soviet Army are the RBM-1 and the A-7-A. These two pieces of equipment show some design sophistication and the quality of components is far superior to that of radios produced prior to 1945. 138/

The chief trends in the radio field in Communist China have been to restore the facilities destroyed, sabotaged, or stolen up to the beginning of the Communist regime in 1949 and to expand the basic rapid communications system of the country in coverage and capacity. China's rapid communications' problem has been somewhat similar to that of the Soviet Union. The vast inland areas of China, like those of central and northern Siberia, have been without adequate wire line facilities. In both cases relief has been sought in radio.

For point-to-point basic service the number of China's radio stations rose from 50 in 1947 to some 328 in 1952, aeronautical stations stood at 54 in 1949, and radiobroadcasting stations rose from 64 in 1946 to 99 in 1952. Data on transmitters in other services are too sketchy to develop trends. The reported interest in a Moscow to Peking micro-wave radio system is covered on page 1 of Sec. I.F,1,b. 139/ 140/

As the European Orbit countries are generally webbed with wire line facilities the need for radio seems to be centered around the mobile services, the mass aural radiobroadcasting services, the international services beyond reach of wire lines and submarine cables, and the jamming "service". In the post World War II period, radio facilities like the wire network were re-established, rebuilt, and expanded. The power of the principal radiobroadcasting stations has generally been increased. New powerful radiobroadcasting stations have been constructed in East Germany and the powers of some are progressively being increased. With the great technological and productive competence of East Germany, Czechoslovakia and Hungary, it is natural that for their own use, as well as for the Soviet Union and other Satellites, modern techniques such as micro-wave radio relays (operating above 30,000 kilocycles) have been applied. Since this whole area confronts the Western World and thus becomes the first line of defense in depth as well as a vital industrialized area to the Soviet Union itself, the Soviet Union can scarcely afford to neglect at least the strategically important components of the rapid communications resources of the area.

In Albania the principal radio development of record is the construction of a 50 kilowatt mass aural radiobroadcasting station for Tirana. In Bulgaria there is reported a new, important radio station or center new Grigorevo village, approximately 26 kilometers east of Sofia. It is said to have been build in 1952 under the direction of Soviet specialists and to be for both civilian and military use. 141/ An additional high frequency transmitter is under construction at Varna (Stalin) which is reportedly intended for radiobroadcasting. 142/ The introduction of radio communication between trains in augmentation of the extensive use of radio in connection with the operation of Bulgarian railroads has been reported. In Czechoslovakia several new broadcasting transmitters have been built. FM broadcasting and television are under experimentation. In East Germany more money is allocated, under Soviet direction, for the expansion and improvement of radio facilities than for wire facilities. Since the end of World War II, East Germany has added several standard AM commercial transmitters for civil use. In addition, several meteorological, broadcasting, and experimental ultra-short wave stations have been constructed. FM broadcasting is in use on a trial basis. Micro-wave radio links have been introduced into the basic system. 143/ In Poland the first television station was opened in January of this year.

c. Facilities Resources in Reserve.

Of importance in any full appraisal of Soviet electromagnetic warfare capabilities is a knowledge of its resources in reserve. Unfortunately data is not available upon which to estimate the nature and magnitude of such reserve if one exists. These reserves, if they exist at all, could fall into four principal categories. First might be the radio transmitters warehoused for future assignment and those in the "ready" reserve wired up and ready to operate if, as, and when needed. Second might be the radio transmitters which are being used for legitimate service now which are backed up by wire line which in turn could handle the traffic. Third might be those radio transmitters which are now handling dummy traffic to keep the facilities and personnel exercised and perhaps to deceive the student of Soviet communications. Fourth might be those radio transmitters which are now handling deception traffic to deceive the outside world. This is pure speculation but the realities of Soviet capabilities in the field of strategic deception suggests caution in this area.

2. Over the Next Two Years.

General

The trends in the Soviet Orbit radio and wire communications profile over the next two years may be viewed from two standpoints. One of these is the deployment and employment of the plant in being. The other is the deployment and employment of new production. These are treated separately, but the changing shape of the profile during the next two years must necessarily be related to equipment production performance during the past few years and perhaps during the next year in order to arrive at an appropriate estimate of the profile to exist in 1954. The time lag between production and actual use makes this necessary.

a. Deployment and Employment of the Plant in Being.

Some clues to this projection may be gotten from subsection 1. Others may be gotten from Orbit plans for the immediate future.

The communications elements in the new Soviet Five-Year Plan (1951-1955) gave an indication of the direction of developments that might be expected over the next two years. Electric power is to be made available to towns and districts by the construction of small and medium power stations, besides the construction of big stations. The sale of radio receivers and televisions sets is to increase. The power of radiobroadcasting stations is to continue to increase and radio frequencies above 30,000 kilocycles for broadcasting and radio relay networks are to be used. A recent study of the production industry, particularly as indicated by electron tube production shows only a normal rate of increase in receiving tubes. However, a rapid development program and concerted effort is being exerted on tubes for special purposes, primarily military. The estimated increase in production for the entire Soviet Bloc tube industry after 1951 is now believed to be much greater than the probable capacity reported early in 1952 with a total estimated output for 1955 now predicted to be nearly three-fold the current 1953 estimates. 144/ The capacity of telephone exchanges in cities (and presumably industrial complexes) will progressively increase. 145/ The Plan is silent on equipment inputs for military and other strategic purposes. It is believed, however, that long-range radionavigation aids, long-range guided missile radio control facilities, long-range radiocommunications facilities for the Red Air Force and the Red Fleet enjoy a high priority. It is also believed that increasing quantities of various types of wire line and micro-wave radio equipment will be installed to increase the capacity of existing basic plant and to increase the geographical coverage of these media to complement or replace the use of radio.

The character of the Soviet mass aural radiobroadcasting reception base is changing rapidly. Though loudspeaker reception had been in vogue in the USSR before World War II, principally in the larger cities, the extension of wire diffusion loudspeaker networks into the smaller cities and villages, begun after the war, is proceeding at a rapid rate as shown in Appendix J.

Communist China's Five-Year Plan (1953-1957) for the year 1953, the only year for which information is available, states that the expenditure for transport and communications will go up about 65 percent over 1952. This means that only some 4 million dollars is to be expended for communications in 1953. This is a very low figure for the state of China's communications plant, its transport facilities, and the great size of the country. No details are given as to what this expenditure will encompass. 146/ While it may be expected that China will attempt to overcome its wire line deficiencies, construction of such facilities takes time. Hence radio facilities, which may be provided at a more rapid rate, will likely be installed at an increasing tempo, at least as an interim alternative in some employments.

The wire diffusion loudspeaker technique is apparently being exploited now, following the Soviet Union pattern.

The European Orbit countries, during the next two years at least, will be increasing wire line facilities in two ways. One of these will be to extend wire line service to those more remote points which heretofore have not had such service. The other will be to continue to increase the capacity of the existing telephone and telegraph facilities which already exist. This will be done principally by the use of multi-conductor cable, coaxial cable, microwave radio links, and channel multiplying equipments. Telephone dialing instrumentation will probably continue to be installed in replacement for manual systems, Several of the countries are considering plans for the introduction of automatic switching for long-distance telephone calls. The continuing construction of wire diffusions networks in all European Orbit countries will be the principal means for increasing the reception base for the domestic mass aural radiobroadcasting service.

While the main emphasis can be expected to be placed on the expansion of wire line facilities, some increase in point-to-point, coastal, aeronautical, and meteorological radio stations is probable. These countries are constructing (and plan to construct) a number of additional radiobroadcasting stations. These include both high and low power transmitters. The majority of these will be operated in the medium frequency band, a few are for low-frequency operation, and a very few for high-frequency use. Many of them are to be low-powered sets designed to amplify and relay signals transmitted by main stations. They will be located in rural areas to increase local reception coverage. The more advanced countries of the Orbit are planning both television and frequency modulation (FM) facilities on at least a limited scale within the next few years. 147/

II. Capabilities of Enlarging Electromagnetic Warfare

Any accurate estimate of Soviet Orbit capabilities of enlarging electromagnetic warfare must necessarily be predicated upon knowledge of current Soviet jamming performance. It ought to be known among other things what the number and characteristics of the transmitters now employed in that effort, their location, their normal service employment if any, and the number of hours per day during which they are used for jamming or are available for that purpose. Such knowledge as is available is spotty, incomplete, and somewhat conjectural. In the absence of such data, only raw estimates can be furnished. Likewise, accurate estimates on the sum total of Soviet Orbit radiontransmitters in being, under construction, in production, and under import from which any enlargement must stem can not be given.

Section I is the base upon which the appraisals structure in subsequent sections is built.

The Soviet Orbit rapid communications profile is a massive organism of great magnitude, coverage, and versatility. Its tentacles reach out over the 12.6 million square miles of the domestic domain and to the principal cities all over the world. It is designed to serve the strategic needs of the Kremlin. It is an organism of great power and it is so used. Politically it serves to obtain control and then to retain it. Militarily it provides a means to exercise command and to control and utilize military weapons. Socially it enchances cohesion. Economically it facilitates control and accelerates the production and distribution of goods and services.

The key consideration in the electromagnetic warfare use of radio is the fact that radio below 30,000 kilocycles does not enjoy monopoly as a medium of rapid communications for all purposes, nor is it indispensable in every case where it is nomopolistic. Strategic planning, systems of priorities, and alternative means offer almost limitless possibilities to the Kremlin for the de-utilization of radio below 30,000 kilocycles. It is these facts which justify the appraisals in subsequent sections of this report.

These appraisals are predicated upon the following assumptions:

a. That the Soviet Orbit cannot do all things at any given instant of time.

b. That the Kremlin enjoys cohesive control of the whole Orbit domain.

c. That, in Kremlin strategies, the end always justifies the means.

d. That the Kremlin would not hesitate to violate international agreements on the employment of radio, if it served its purposes to violate them.

e. That Kremlin strategic planning and action always considers counter planning and counter action (retaliation included).

f. That convenience of the individual must yield to the convenience of the State.

g. That communication security is a component of security of the State.

h. That the Kremlin must depend upon rapid communication means for the exercise of control.

i. That steady supplies of intelligence are indispensable to Kremlin strategic planning and action.

A. Strategic Costs

1. Diversion of Resources to Production of Electromagnetic Warfare Equipment

Information on production and industry expansion available as of 1 January 1953 has been analyzed showing that the increase in production of receiving tubes is about as previously estimated, but that the production of special or other tube types is nearly twice the originally estimated amount. This indicates a rapid development program and concerted effort is being exerted on tubes for special purposes.

The electronics sector of the industry in the Soviet Bloc furnishes equipment for the armed forces, the civil communications network, and civilian radio and television sets. Military equipment is given the highest priority, with communications equipment second, and equipment for consumers a poor third.

To illustrate the cost of a program to be used by the Orbit in jamming operations, it is necessary to make a number of assumptions and estimates.

It is estimated that the present jamming operation against the Voice of America program utilizes 880 jamming transmitters. If an all out jamming operation was started, it probably would be at least double the present operation and, for round numbers, might use 1000 additional transmitters, of, say, 10 kw power output.

The cost of these transmitters in the USA might vary over a considerable range from $35,000 for a high quality broadcast unit to a simple industrial high frequency generators of 20 kw for $7,500, both capable of accomplishing the purpose of jamming.

A standard communications type voice transmitter of 10 kw would be entirely sufficient for jamming operations and its estimated cost in US dollars would be $22,000. This transmitter of 10 kw power will be used for a typical jamming operation input analysis.

Suppose that 1000 of the 10 kw transmitters were in one year, at the cost of $22,000,000. This cost would, of course, vary with the power of the transmitters. Using this figure of $22,000,000 and comparing it with the total production value of the electronic industry of the Orbit which is estimated to be $750,000,000 for 1952, the jamming transmitter segment would be about 3% of the total industry.

The 1952 production of power tubes of the types that would be used in these transmitters were produced for existing needs in amounts sufficient to fill this requirment. The additional requirement for operation and spares would probably be met by insignificant expansion of tube plant facilities. If this transmitter program was extended to cover two years instead of one year, the cost would then only be 1 1/2% of the estimated total electronic industry.

The cost of antenna systems would depend entirely on the types used, and these could vary from a simple curtain type to elaborate multi-tower installations, thus no effort is made to include the estimate of this cost.

It is felt that the 1 1/2% or 3% cost of the equipment could be absorbed without any serious displacement in the electronic industry . greatest cost to the national economy would be the disruption of internal radio communications facilities that would have to be replaced with other methods of communications, such as wire line, micro-wave, and airmail. concentrated jamming program by the Orbit of external channels would be bound to also jam some internal channels.

Recent estimates indicate that the electronics industry of the Soviet Bloc is capable of providing simultaneously a minimum level of civilian radio and television equipment, an entirely adequate civilian and military communications network, and a large amount of high-priority military electronics equipment. Although the Soviet Bloc is not able to manufacture unlimited quantities of all possible categories of electronic products, all evidence now indicates an entirely adequate supply of those military and essential equipments which the Soviets consider important. In view of the over-all magnitude of the Soviet Bloc electronics industry, with its heavy concentration on military and other specialized items, it is believed that the industrial effort which would be required for a large scale production of electromagnetic warfare equipment could be provided without noticeable effort upon existing essential electronics production quotas. In brief, the strategic cost of diverting industrial resources to the production of additional electromagnetic warfare equipment could be provided without noticeable effect upon existing essential electronics production quotas.

2. Diversion of Communications Facilities from Normal Service to Electromagnetic Warfare Service.

One quick method of arriving at the estimated sum total number of existing Soviet Orbit transmitters is to use the reported number of radio transmitter stations locations which are shown on the map in Appendix B to establish a minimum. There are some 2,300 locations indicated on the map. Assuming that each location contains at least one radio station and that each radio station contains two transmitters, one for working and one as an emergency spare, the minimum number of transmitters comes to some 4,600. If it is assumed that the emergency transmitter at each of the 2,300 locations mentioned above were devoted to jamming operation, it can be seen that sufficient equipment is at hand for a substantial jamming effort. Obviously many locations contain many more than two transmitters. Moscow, for example, is not only the communications focal point of the USSR, but also of the whole Orbit. It is estimated that at Moscow there probably are several hundred transmitters operating in all of the various services covered in this report. (Assuming simultaneous need, there are at least some 30 for communications with other main USSR centers; some 35 for communication with other Orbit and non Orbit countries; some 27 for radiobroadcasting of various kinds; untold numbers for second, third, fourth, etc. circuits with main centers where the load is high; and obviously others of significance in the aeronautical, maritime, meteorological, etc.services). Other main and minor centers of graduated lesser importance, numbering in the hundreds, probably have transmitters numbering somewhere between the several hundred figure for Moscow and the minimum figure of two. Using an average figure of 25 transmitters in addition to the minimum two for say 200 main and minor centers, this comes to another 5,000 units, or a sum total of some 9,600 significant transmitters.

There are believed to be numerous conjectural means by which the Kremlin could enlarge electromagnetic warfare through diversion. Only operational means are considered here. Certain technical means, not considered appropriate in this report, are also available. Some of these operational means are covered in the following paragraphs but not necessarily in the order in which they would be invoked if available.

a. Use of Normal Spare Emergency Transmitters.

Though Soviet policy with respect to the provision of spare transmitters is not known, it is normal practice in most modern coutries, where continuity of service is a factor, to provide such "fallback" facility. Pursuant to the estimate already made that some 2,300 radio stations may have spare transmitters, it appears from this that a most considerable number of useful jammers could be derived from this source.

b. Use of Dummy Service Transmitters.

In the strategic employment of communications, belligerent nations over the years have sought to conceal the imminence of an operation as reflected in surges of communication activity by loading the channels between these surges with dummy traffic. It is not known whether the Soviet Orbit utilizes this procedure today but it must be aware of its value. In any Soviet compression of the use of radio these troughs between crests or surges would tend to disappear, thus releasing some transmitters.

c. Transmitters Used for Practice Purposes.

It is not uncommon to give final training to radio operators and at the same time keep facilities in a state of operational readiness for any assigned mission by handling practice traffic on live circuits. It is not knowntc what extent this training aid is used by the Soviet Orbit. If used, suspension of the practice would release additional transmitters for jamming.

d. Transmitters Handling Deception Traffic.

Communication strategy includes the transmission of traffic designed to misinform potential and real enemies. The technique is an old one, undoubtedly known to the Kremlin. It is not known to what extent this practice is being used today, if at all, or what if any plans the Kremlin has made for its future use. If used today, suspension of the practice would release an unknown number of transmitters for jamming purposes.

e. Strategic Spare Transmitters.

As a safeguard against revelation to potential enemies of the existence of certain strategic radio transmitters, is seems likely that the Soviet Orbit would provide in readiness for strategic use, if, as, and when necessary, considerable numbers of transmitters which would not otherwise be used at all.

Nothing is known of the actual existence of such transmitters in the Soviet Orbit, but it must be assumed, in the interest of safety, that some exist. If they exist and Kremlin strategy so dictated, they could be invoked to fortify a jamming campaign.

f. Transmitters Performing Non-essential Services.

It is speculated that one of the more prolific sources of additional transmitters for jamming operations would be the reduction or suspension of non-essential wire and radio services. This applies particulary to the domestic and international point-to-point and mass aural radiobroadcasting.

(1). Domestic and InternationlPoint-tc-point Services.

The Soviet Orbit point-to-point services handle considerable quantities of so-called public correspondence, telegrams and conversations of the public, as private individuals. This may he called system "slack." The percentage of slack to total traffic is probably much less in a non-consumer, non-free enterprise economy, like the Soviet Orbit, than in true democracies. Yet is is believed to be significantly appreciable vis-a-vis electromagnetic warfare enlargement. It is probably not beyond the realm of Kremlin decision to decree that such traffic is non-essential and hence to suspend its handling by rapid media. Probably the great bulk of such traffic could be diverted to air mail, regular mail, and other media while some would simply disappear. In the interest of communication security it is likely that under normal circumstances, where a choice of media is between wire (land and submarine) and radio, this innocuous slack traffic would be handled by radio, wire facilities being saved for intelligence-containing strategic traffic. The cessation of such traffic would directly help to release radio transmitters and at the same time indirectly enhance the capacity of wire facilities for such strategic traffic as in now being handled by radio, thus possibly releasing additional transmitters for jamming purposes.

(2). Mass Aural Radiobroadcasting Service.

The tabulation in Appendix E shows a total of known radio transmitters employed for mass aural radiobroadcasting in the Soviet Orbit of 421 transmitters. Also shown are the bands in which they operate and the power categories into which they fall. It is possible that some of these radiobroadcating transmitters are included in the almost 900 transmitters now thought to be employed in jamming, full and part time. Assuming, however, that none of these radiobroadcasting transmitters are presently operating as jammers and that the Soviets might, for strategic reasons, decide that radiobroadcasting in its present form is non-essential, all or most of these radiobroadcasting tansmitters could be diverted to jamming. This extreme situation would increase the number of transmitters that could be diverted to jamming, by approximately fifty percent.

There is some evidence to suggest that mass aural broadcasting, at least domestically, is progressively depending less and less upon radio as the link between the studio and the listener in the Soviet Orbit. Appendix J points up the trend in broadcast reception. It shows that mass reception by radio is apparently losing ground to mass reception by wire. The wire diffusion net, of which there are already tens of thousands in the Orbit, is a closed invulnerable system offering absolute government control of program selection. The wire diffusion exchange center from which the wire lines to the loudspeakers radiate is in effect a broadcasting studio. Party members are in charge to insure sanitation of program content. The center not only relays programs from broadcasting stations but can and does originate programs. It usually contains a microphone and transcription equipment. Many of these centers enjoy wire connections to the nearest city containing radiobroadcasting stations. Some of the wire diffusion exchanges still have to rely on radio receivers for the reception of programs which are fed into the lines servng the loudspeakers in the network but the areas dependent on radio links are decreasing. The cities and villages of the Orbit are reaching toward the radiobroadcasting station cities with wire and thesesame cities in turn are reaching out to other cities and villages with wire. The non-wire or radio gap seems to be closing with wire line circuits gradually assuming more of the distribution function.

In the meantime the longer distance relaying lin's, such as between Moscow and the other main radiobroadcasting centers are generally radio, though some relaying is done by wire now and with the expected installation of additional wire line circuits more transmission of programs by wire can be anticipated. In the meantime, dependence on the radio link for rebroadcasting could be overcome by the transport of program transcriptions and script by air, rail or other means. Because the Soviets can control the timeliness of all news reaching the masses, the importance of this factor in the reporting of news is not as great as in, for instance, the U. S.

Should the Kremlin decide that it were strategically desirable, some increment in jamming transmitters or jamming transmitter time could be obtained from the discontinuance of its international radiobroadcasting service, as reflected in Appendix G. As it is likely that some of the transmitters tabulated in Appendix E are employed in the international broadcasting service, it is not thought any great increment could be derived from the suspension of this service.

(3). Others.

As for other services there seems little likelihood that any appreciable sources of additional transmitters could be obtained from other services. Some of these services employ large quantities of transmitters but the powers are probably low, such as the land-mobile services. In some other services, the functions they perform are thought to be too vital to suspend. These include the aeronautical and maritime mobile services. The tabulation in Appendix C shows that the Soviet Orbit operates 242 international radio circuits. Some 74 of these radio circuits are between Orbit countries, and the remaining 168 radio circuits are with non-Orbit countries. While probably several hundred additional transmitters of considerable power might be derived from this service, there is grave question as to whether it would be strategically sound for the Kremlin to forego any of this service. Within the Orbit they are probably necessary to back up wire command circuits. Externally they seem indispensable to maintain commercial, diplomatic, and intelligence liaison for the prosecution of Soviet aggressive foreign policy and Communist operative activities. However, foreign reaction to any aggravated cold war tactics on the part of the Kremlin could result in foreign suspension of Soviet Orbit circuits, thus releasing Orbit transmitters for jamming uses.

g. Transmitters Employed Only Part Time in Essential Services.

Not all transmitters in all services are used on a full time basis around the clock. In fact it seems probable that most transmitters are not so used. But transmitters assigned to circuits where readiness-to-service is a vital factor, rather than steady traffic volume, should be eliminated from that large group. Included in these are strategic command services, military, aeronautical, and maritime communication services and radionavigation and radio control services. Of the estimated large remainder, among which are the hundreds of lightly loaded point-to-point, meteorological, and other services, many hours of jamming service availability seem evident.

h. Transmitters Conducting Services Which Can Be Shifted to Other Media.

The principal alternate rapid media for point-to-point service are the wire line and micro-wave radio. The map in Appendix B shows the areas in which there is some wire line availability. No data are available on the existence of micro-wave radio. In the wire line areas, when radio is used also for point-to-point service, traffic could be shifted to wire facilities, thus releasing significant numbers of transmitters for jamming purposes.

i. Transmitters Released by Acceptance of Delayed Service.

Acceptance of delayed service can contribute to the availability of transmitters for jamming service. Under conditions where delayed service policies can be tolerated, the traffic load is adjusted to the facility, rather than the facility being adjusted to the traffic load. Minimization in use of facilities is thus achievable. There are at least three methods by which to do this.

(1). Reduction in the Number of Direct Circuits.

This method is best described by illustration. If the 30 assumed main communications cities of the Soviet Union in Tables 1 and 2 section I-A-1-a-(1), which shows the highest number of frequency assignments, each communicate with each other in both directions all at the same time, the number of transmitters involved is 30 x 29 or 870 transmitters. If the service can tolerate delays, traffic relaying can be invoked, thus reducing the number of cities involved in joint inter-communication. If the number of cities is reduced by half, to 15, then the number of transmitters involved under the same conditions would be 15 x 14 or 210, a reduction in transmitters of about 75 percent. While this piles up traffic at the fewer centers, the procedure under (1) is applied.

(2). Invocation of Priorities in Traffic Handling.

There is evidence that the Soviet Orbit now bases tariffs upon priority of service classifications. Under strategic necessity, the relative classifications might be retained but the overall speed of service from origin to destination for all classes might be appreciably reduced. New priority classifications to cover various classes of governmental strategic traffic could be invoked, if they do not already prevail.

(3). Flattening Out of 24-Hour Traffic Load Curve.

Combined with the other elements in this subsection, leveling off of the load curve so that channels of communication are kept loaded to capacity over the 24-hour day, and deliberate procedures for feeding traffic into the system around the clock, maximize circuit efficiency and thus help to reduce transmitter requirements. No estimate can be given as to the number that can be released for jamming missions by the application or further application of these methods.

j. Increase in Speed And/or Capacity of Residual Facilities.

The number of required service transmitters can be reduced by increasing the speed at which they transmit telegraphic traffic. However, there are operational, technical, and propagational limits to which this can be done. The capacity of a transmitter can also be increased by increasing the number of telegraph and telephone channels served by a single transmitter. The same limitations apply as those of increased speed. It is not known to what extent Soviet Orbit transmitters are operating maximally in these respects. It seems safe to assume that the Soviet Orbit is capable of squeezing out additional capacity from many of its transmitters.

k. Reduction of Service.

To squeeze out additional transmitters for jamming purposes it is probable that the scope and/or depth of almost all radio services could be reduced in one way or another. The amount of reduction achieved would obviously vary with the strategic or economic importance of the service currently being rendered. Reduction is an alternative to elimination of a service altogether and offers a wide range of qualitative and quantitative choices. This method is involved in some of the methods previously described, but here it stresses a specific approach which should be fruitful if broadly applied to all uses of radio in great detail. Under critical conditions, it is usually found that what is thought to be essential or necessary radio service can be dispensed with or greatly reduced with little or no adverse effects. Significant numbers of additional part time or full time transmitters may be made available for jamming from this source.

l. Reduction in the Number of Transmitters at Locations Conducting a Variety of Radio Services.

Locations conducting a number of different radio services may have assigned one or more individual transmitters to each service conducted. This practice is not always necessary where the services performed are not continuous or where readiness-to-serve is not a prime factor. For example, if a meteorological radio station is equipped with a transmitter for the collection and/or dissemination of weather data and the station itself is also a unit in the basic communications system, for which it has a second transmitter it is possible that one transmitter could perform both services. Normally weather report transmissions are periodic and basic communications system traffic at many isolated weather stations locations is relatively light. Under such circumstances it is possible that a single transmitter would suffice. This technique might be a likely source of additional jammer transmitters.

m. Scheduling of Residual Radio Services.

It is possible that in some radio services which must be conducted under all or nearly all conditions and circumstances that the service can be scheduled as to time, geographic area, frequency band, and/or transmitter assignment. These elements might be brought into schedule singly or in combination to arrive at a plan of operation which would produce an optimum availability product of transmitters, time, area and frequency band for jamming operations.

The enumerations (a) through (m) in the foregoing give a number of possible methods by which capability of enlargement of electromagnetic warfare might be achieved. Since it is not known to what extent these methods are now employed to achieve current jamming performance, no quantitative estimate can be hazarded on the increment that could be derived therefrom. However, if the methods are considered in their entirety, it is believed that full and thorough exploitation of them would appreciably enlarge present capabilities.

The strategic cost of utilizing these diversionary capabilities is thought to vary exponentially with the extent of their utilization. This is believed to be true because rapid communications are fundamentally means for accelerating human action and accelerated human action in turn imposes demands for additional accelerating means.

3. Diversion of Manpower

With respect to the enlargement of electromagnetic warfare, the diversion of manpower falls into two broad categories: Diversions from existing radio services and diversions from other sources to man new facilities.

It is estimated that the strategic cost of diversions from existing radio services would be relatively inconsequential. It appears that the principal need for additional manpower to enlarge the jamming effort would be for additional radio monitor operations, transmitter attendance, and jamming network control operations. It would seem that most of these requirements could be met by those released through curtailment of legitimate radio service operations. However, from the standpoint of the whole manpower supply, some additional manpower would be consumed directly and indirectly in consequence of curtailed rapid communications services.

The construction, installation, operation, and maintenance of new jamming facilities would directly entail the consumption of additional supplies of trained manpower.

4. Maximum Utilization of Present Capabilites Over the Next Two Years.

The strategic cost of maximum utilization of present capabilities (as developed in section 2) over the next two years are considered to be almost intolerable. If on the other hand new jamming facilities were manufactured (as mentioned in section 1) and the unused facilities such as emergency transmitters were utilized to the extent needed for effective jamming at external communications systems it is quite possible that the overall strategic cost would not be intolerable, and well within the capabilities of the Soviet Orbit. It is true that to provide material and manpower for new construction some diversion of resources would be required, but it is thought that this could be obtained from the less critical programs. This is believed to be so without consideration of the potential effects of retaliatory jamming.

One of the prime objectives of the Kremlin is given as the rapid expansion of the strategic power (both economic and military) of the Soviet Orbit. It seeks to achieve that expansion at an accelerating rate. Rapid communication, an accelerating resource itself, must precede and keep pace with this expansion. Any modern economy because of the complexity and interdependence of the various activities of the nation does have adequate facilities for rapid communication. In the Soviet Orbit where control has been centralized to an extremely high degree and where economic and military activity is dispersed over a huge geographical area, rapid and sure communications are necessary and essential. In the case of the USSR itself, in which the preponderance of new expansion is taking place east of the Urals where rapid communications facilities are scarce (particularly landlines) there is little doubt that increases in these facilities will inevitably continue. Hence it would seem that the Sovlet Orbit would need to develop more and more of these resources rather than to consider any significant curtailment therein.

S-E-C-R-E-T

Where there is a choice of media the Kremlin can favor wire over radio, or physical media over both. There is grave question, however, whether the Orbit, at least in those huge areas where rapid communications resources are relatively undeveloped, could afford the luxury of doing anything itself that would diminish or tend to diminish, for the next two years at least, the rate at which it seeks to accelerate the growth of strategic power. Nor does it seem likely, for the same reasons, that the Orbit would cherish the potential retardational effects of retaliatory jamming upon that rate.

Maximum utilization could impair the politically cohesive and control benefits of domestic mass aural radiobroadcasting, the agitative and propagandistic potency of international mass aural and press radiobroadcasting, the efficiency of economic performance, the cultural and social satisfactions of the people derived through and from rapid communications services, and the strategic and tactical contributions of radio services for the exercise of military command and the effective deployment and use of military weapons.

5. Increasing Present Capabilities over Next Two Years.

On the basis of the post-World War II rate of growth of rapid communications facilities in the Soviet Orbit and of the production and importation of the means for providing those facilities, it seems clear that the Soviet Orbit could markedly increase its electromagnetic warfare capability. The amount of increase would of course directly depend upon Kremlin intentions with respect to jamming. If future jamming potential dominates production planning and rapid communications systematization in such wise as to diminish dependence on radio below 30,000 kilocycles, the increment in capability could be large. The use of wire, and radio above 30,000 kilocycles in all feasible applications, as well as enlargement and improvement of rapid physical transport, would accomplish this.

But even without any Kremlin intentions to enlarge jamming capabilities as such, the growth of radio facilities to support all other plans and intentions would automatically yield an increase in capability.

B. Military Costs

1. Diversion of military resources to production of electromagnetic warfare equipment

If there should be a policy decision to enlarge the scope of offensive electromagnetic warfare, the decision would be military as well as political. There would, then, be no question of diverting military resources, but rather of re-allocating equipment supplies.

There have been reported shortages of critical materials in the electronics industry, and the continued import of certain critical materials (acquired from Western sources covertly or through transshipments) indicates the possibilities of low inventories or an effort to stockpile. However, the low rate of output of transmitters and transmitting tubes, particularly in East Germany, is at least partially due to lack of demand. It is believed that production of high-power transmitters under 30 megacycles could be increased significantly without diverting large amounts of critical resources. The requirements placed upon the electronics industry in a state of enlarged electromagnetic warfare would be fully commensurate with the capacity of the industry to sustain increased production.

2. Diversion of Military Communication Facilities From Normal Service to Electromagnetic Warfare Service

From the meager information available, it appears that the basic communications network within the USSR offers relatively little cushion, and from this it might be postulated that the military networks offer little excess capacity. If this is true, diversion of military communications facilities from normal service to electromagnetic warfare might eliminate available cushion and reduce needed capacity.

3. Diversion of Manpower

Military personnel presently engaged in communications could, and probably would, be used to conduct electromagnetic countermeasures (ECM). The more obvious types of jamming could be conducted with little or no additional training, whereas complex types would require commensurate training.

It is believed that the scale of electromagnetic warfare could be greatly increased without significant diversion of manpower used in the production facilities of electronic equipment. A large reserve of trained manpower can at any time be diverted from production of civilian broadcast receivers television receivers and other non-critical end-products to whatever priority tasks confront the industry. There is little doubt that, within a relatively short time, the electronics industry itself can affect the necessary reallocation of labor, without affecting other industries or tapping military manpower resources.

4. Military cost of current effort

The military cost currently cannot be distinguished from the total cost.

The production cost of this effort may be considered military or non-military, depending upon interpretation and effect. It is known that most key Satellite electronics manufacturers produce dominantly for military purposes and in several cases up to 90 per cent of such output is destined for the USSR. The sparsity of information on all electronics production useful in electromagnetic warfare precludes an estimate of that portion which may be considered strictly military.

5. Maximum utilization of present capabilities (over next two years)

Maximum utilization of present capabilities over the next two years would place a minor additional strain on the production facilities that support the jamming effort. Maximum utilization of existing facilities would be reflected in a heightened demand for replacement tubes. The electron tube industry is believed capable of meeting this demand; indeed, there are several examples of production type shift and induced speed-ups to turn out tube types in critical shortage. However, the military cost of maximum utilization of all plant is not readily assessable.

6. Increasing present capabilities (over next two years)

The history of the Soviet electronics industry since 1941 has been one of continuous expansion - of plant, personnel, and production. That this expansion is continuing apace is evidenced by the current development of the electron tube industry. The level of output of tubes is the key to measuring the capability of the electronics industry. In the tube industry of the USSR five new plants are reported to be in process of construction at the present time. It is most logical to assume a corresponding expansion of the dependent electronics assembly and components parts industry.

While the available evidence does not permit the determination of where emphasis is being placed in the development of additional plant, it is certainly reasonable to expect that the requirements of an electromagnetic warfare program are well in the fore. We can anticipate that the industry will be geared to support the constantly increasing capability of the jamming networks.

III. Vulnerability and Probable Effects of Retaliation Upon Orbit Communications Operations.

In this report vulnerability does not refer to the susceptibility of Soviet Orbit radio circuits to the direct technical effects of radio propagation generated by retaliatory electromagnetic warfare operations. Those effects are treated in other reports. For the purposes of this report vulnerability is defined as the susceptibility of the Soviet Orbit to disruptions in the exercise of the sum total activities of the state in all of its ramifications, in so far as that susceptibility is conditioned by rapid communications. Here the key to an assessment of vulnerability is the measurement of the strategic essentiality of Soviet Orbit radio services for that purpose. In this report the "probable effects of retaliation" encompasses an assessment of the harm that retaliation can inflict upon those instrumentalities, assuming that retaliatory electromagnetic warfare is effective.

A. Vulnerabilities.

The degree of essentiality of the contribution that a rapid communication resource makes to the sum total activities of the state in all its ramification is considered to be the measure of vulnerability of that resource. Where there is no essentiality, there is no vulnerability. To avoid delving into abstraction, it is necessary to limit consideration here to strategic essentialities. Where essentiality is strategic, the vulnerability is concomitantly strategic. Section I gives some clues as to the strategic essentialities of rapid communications in terms of surmised service performed. Rapid communications channels may be classified according to the strategic essentiality of the service they contribute. These are command channels, intelligence channels, operational channels, and support channels. To assess vulnerabilities, it is necessary to examine the existing capabilities of the Soviet Orbit rapid communications profile to supply the four classes of functional channels mentioned.

1. Command Channels.

Command channels are those channels required for the exercise of supreme authority and control. Their lack of availability may jeopardize the safety and security of the Soviet Orbit or a portion thereof. All segments of the Soviet Orbit hierarchy are assumed to require the use of such channels. Politically they are vital to control and cohesion of the masses of peoples and for the execution of domestic and foreign policy. Economically they are indispensable to centralized economic control of production and distribution. Militarily they are vital to the exercise of air, sea, and land power. Such channels are likely to emanate from the headquarters city of the country and from alternate emergency headquarters cities to all strategic points in the domain. Moscow may be assumed to enjoy direct command channels to all Orbit country capitals, to all USSR Republics and other political subdivisions, as well as to economic control centers and principal headquarters of the army, navy, and air force wherever located.

Command channels are not necessarily channels of volume service. Instantaneous readiness-to-serve, certainty and security of service are the prime prerequisite of such channels. Such channels are not apt to be cluttered up with administrative or other traffic which may impair the instantaneity of availability for command communications. It is surmised that such channels in the Soviet Orbit are backed up with alternate channels as protection against loss of the primary channel through sabotage, accident, or acts of God. As is seen in Appendix B the European portion of the Orbit is well covered with principal wire line facilities. Primary, secondary, and if necessary, additional fall-back channels may be available over two or more different wire line routes (and in some places, micro-wave radio circuits as well). Within this European area little if any dependence on the radio media for point-to-point command channels appears to prevail for intra area service. But even here sabotage of wire lines (and micro-wave circuits) by anti-Communists in satellite countries is a factor. East of the Urals and in large portions of Communist China the situation is markedly different. Wire line coverage is not only incomplete, but alternate wire line routes do not exist;* the only complete transcontinental route follows the trans-Siberian Railroad. Here dependence upon radio as a rapid media appears heavy. However, the dependability of a radio circuit varies with its length. Furthermore, since the susceptibility of a wire line to interruption or operational maladjustment is a direct function of its length, wire command channels between, for example, Moscow and the wire line points to the far north and east can scarcely be depended upon for readiness-to-serve continuity.

As for international point-to-point command channels which serve foreign political, intelligence, and agitative needs, dependence is unavoidably heavy upon radio. Wire lines are generally available on an intra-continental basis and some, but not all, continents are interconnected by submarine cable. But even where wire facilities are available, relay of traffic through neutral or unfriendly (to the Soviet Orbit) countries would render such relayed traffic subject to delay, destruction, or compromise. The Soviet recognition of these vulnerabilities accent their provision of the so-called "closed" international radio channels, of which those reported to exist are listed in Appendix D.

From the material at hand and analyzed for this report, it seems convincingly clear, if one attempts to view the Soviet domain and the rest of the world from the vista of the Kremlin, that the vulnerability of Soviet command channels is rather high in all areas except possibly in the European Orbit.

2. Intelligence Channels.

Data was not available on the existence and character of Soviet Orbit intelligence channels. Undoubtedly some exist. They are mentioned here because their strategic importance should be recognized and efforts should be made to fill gaps in information thereon.

3. Operational Channels.

Operational channels are those channels required for the optimum deployment and employment of strategic power where time is precious and dependability of service vital. From the aspect of dependence on radio, operational channels are of two principal types. One type, the non-mobile, partly depends upon radio as the medium. The other, the mobile, depends almost wholly upon it.

* This statement refers to the strategic meaning inasmuch as parallel lines do not exist with separation exceeding 20 miles. Technically there are 6 separate pole lines paralleling the Trans Siberian Railroad from the Urals across Siberia. These pole lines are separated by a distance varying from 100 feet to 100 yards. This spacing, while not important from the standpoint of its capture by a foreign power, substantially decreases the vulnerability of the lines to damage from such unpredictable events as falling poles, breakage of cross-arms, short-circuits from broken wires, train wrecks, and weather conditions.

a. Non-Mobile Operational Channels.

The services performed by non-mobile (includes portable) operational channels are somewhat of the same type as point-to-point command channels, but the urgency, importance, and dependability of the service they perform may be of a lower order. All segments of the Soviet Orbit hierarchy and subordinate echelons (political, economic, air, sea, and land) require the services of such channels. The urgency, importance, and dependability of the service generally varies directly with the organizational level of the echelon. They may be looked upon as command-tactical channels, subordinate only to command channels themselves. There are apt to be many more of these non-mobile operational channels than command channels. While the wire-radio media facilities relationship with respect to command channels holds for non-mobile operational channels, the lesser exacting service requirements permit, at least in some cases, the employment of less rapid communications facilities, such as the rapid forms of transport, air, rail, ship, and vehicle. Hence the vulnerability of Soviet non-mobile operational channels is still high, but not so high as for command channels.

b. Mobile Operational Channels.

Mobile channels are those operational channels which cannot perform their service without the use of the radio medium. For this reason they are, as a group, the most crucial to Soviet Orbit electromagnetic warfare considerations. The services which these channels conduct are today vital to the development and employment, civil and military, of air, sea, and land power. They contribute to the effectiveness and acceleration of economic activity, and they aid in the exercise of political control and surveillance. They fall into two general types. One type is the mobile communications channel, the other is the radionavigation and radio control type.

(1) Mobile Communications Channels.

Mobile communications channels are those channels which utilize the radio medium for communications between mobile units, such as aircraft, ships, vehicles, and trains, and between land stations and mobile units. There are thousands of these all over the Soviet Orbit. The length of the channel ranges from a few miles to thousands of miles. The volume of service rendered per channel is generally not high, but the urgency, importance, and dependability measures of the service requirement grows larger and larger as mobile units, such as aircraft, ships, and tanks become larger and more deadly, and the number of units organized into a flight, force, or squadron increases. The vulnerability of the service these channels conduct depends upon the number, characteristics, and the type of missions of the units involved and could approach the strategic importance of command channels, as in the case of a large flight of long range bombers armed with atomic bombs on an attack mission.

(2) Radionavigation and Radio Control Channels.

Radionavigation channels are those channels which serve as aids to safe and accurate air, sea, and land navigation, both civil and military. They also furnish location data for bombing and other missions. Radio control channels are those channels which may furnish control of guided missiles. There appear to be considerable numbers of the former radio service channels, but nothing is known of Soviet Orbit guided missile control channels. The combat need for large numbers of radionavigation and radio control channels is probably not continuous. In fact it is well to suspect that the more vital of these channels are shrouded in secrecy to be employed only if and when it becomes strategically and tactically imperative. Non-combat needs are assumed to be continous, serving all useful activities of the Orbit, political, economic, and military. Some of the radio-navigational facilities are shown in Appendix F, but there are believed to be many more of them. The vulnerability of Soviet radionavigational and radio control services is considered generally high for combat usages but, in the case of radionavigation for non-combat usage, much lower. This is considered so because there exist alternative methods of navigation, though some of them may incur added hazards to safety and efficiency of operation.

4. Support Channels.

Support channels are those channels required for the exercise of Orbit housekeeping functions. They include all those stragetic channels not encompassed in command, intelligence, and operational channels. They are the most numerous class of the four. Such channels are known by many other names. Among these are administrative, logistic, executive, public, private, mass communication, news propaganda, industrial, etc. For purposes of international radio regulation, they include all the radio services described in Section I. These channels serve all segments of the government, industry, and the military.

The vulnerability of support channels is generally less than that for the other three classes. The service they perform usually can tolerate some delay or can be dispensed with. Less rapid media, such as physical transport, can be invoked as a satisfactory alternate. Under certain critical conditions, circumstances, or situations where time is the crucial element, vulnerability could be high. On the whole the vulnerability of this class of channel would probably rise exponentially with the elapse of time during which the service they perform was unavailable, commencing at a low level of essentiality and rising rapidly until readjustments can be made. In the interim there would occur a cumulative slowdown of the sum total activities of the state.

The above discussion of the four classes of channels reveal what appears to be a significant implication for retaliatory electromagnetic warfare. The discussion, in effect, arrives at the speculative conclusion that the channels of greatest vulnerability (command) are fewest in number and that the channels of least vulnerability (support) are great in number). If this conclusion is sound, then it must follow that retaliatory jamming should be selective and concentrated on the fewer channels (command) of maximal service vulnerability. But this conclusion must be as obvious to the Kremlin as it is to outsiders. Any Soviet intentions to expand its electromagnetic warfare operations would undoubtedly be conditioned by this awarenss.

B. Probable Effects of Retaliation Upon Orbit Communications Operations.

Retaliation implies the existence of enlarged Soviet electromagnetic warfare. It is safe to assume that Soviet decision to enlarge would probably be preceded by Soviet decision of intention followed by sound planning. Planning, among other things, would encompass means to circumvent the speculative conclusion that the channels of greatest vulnerability (command), being fewest in number, would, if they could be identified in the spectrum, be subject to selective and concentrated retaliatory jamming, hence effective jamming. Planning would also take into account the exposure of Soviet radio channels to its own jamming.

The probable effects of retaliation may be of three kinds: End effects upon the sum total activities of the Orbit; the effects upon the operational utilization of the rapid communication resources; and the diversion of resources.

1. End Effects upon the Sum Total Activities of the Orbit.

Soviet planning to enlarge electromagnetic warfare would probably include plans to reduce the end effect on Orbit activities as much as could be anticipated. But, assuming a major order of the effectiveness of retaliatory jamming*, a slowdown in the sum total of activities to the Orbit would be expected to ensue. This is consequent to delay, confusion and losses in rapid radio communication services, with chain reactions tending to permeate the entire Orbit, possibly aggravated by some sabotage in some Orbit countries. The instantaneousness of political soundings and reactions may be impaired. The exercise of military command and the conduct of military operations may be jeopardized. The wheels of industry would likely slow down. The continuing struggle to achieve and maintain mass cohesion, potency and popularization oriented to the Kremlin may be weakened. The slow down would begin at a low level, probably rise rapidly, and begin to recede after readjustments could be made.

Quantitative analysis of the effects of retaliatory jamming, if possible at all, would be exhaustingly laborious.

2. Effects upon the Operational Utilization of the Rapid Communications Resource.

The effects of retaliatory electromagnetic warfare upon the operational utilization of the Orbit rapid communications resource would depend to some extent upon the self-induced effects introduced by the Soviet Orbit to enlarge its jamming attack (diversion of service transmitters to jamming, and self jamming). The effects would also depend upon the effectiveness of counter-attack. Theoretically the ultimate end product of the two actions would seem to be to destroy completely the utilization of the radio spectrum below 30,000 kilocycles for legitimate service. On the way to that end, the wire, microwave radio, and other rapid and less-than-rapid physical media would be obliged to carry an increasingly heavy burden until that burden was total.

Some of the methods of enlarging a Soviet attack are given in Section II. These methods cover operational readjustments, diversions to other media, suspension of some radio and some other rapid services. They represent capability not necessarily certain utilization for jamming. Diversion or increase of production would have a direct bearing upon the extent to which the operational methods described in Section II would be employed. The decision as to the way in which these

* In time, duration, area of coverage, signal levels, emission characteristics, spectrum coverage, technical and operational control and systematization, and ability to find and identify the choicest targets.

operational and production factors are to be brought together to comprise enlargement remains alone of course, with the Kremlin, assuming Kremlin initiation of enlargement, but not alone with the Kremlin once that initiation takes place. Depending upon the degree of effectiveness, retaliation would probably induce Soviet decision to apply or to a greater extent some of the methods of section II that are not employed in initiating enlarged jamming.

In the field of military communications, it is of interest that the Soviets have developed considerable proficiency in the design of high powered transmitters, high-powered vacuum tubes and directional antenna systems, which would make jamming by non-orbit countries more difficult.

Although the standard Soviet Army procedure for defense against enemy jamming consists of a high refinement of operator techniques, the Orbit employs a first class system of signal security based on World War II German VS U.S.S.R. operations, with changes in frequency, call signs, and the use of cipher keys. These actions provide a safeguard against selective controlled tactical jamming.

In summary, it can be said that although the Orbit's radio nets are vulnerable to a well organized system of forward area jamming, a number of factors such as signal security (radio silence) anti-jamming equipments, and directional antenna systems may eventually provide a formidable barrier to effective non-orbit jamming operations.

In considering the effects of retaliation igf jamming on Orbit tactical nets, it must be remembered that the bulk of electrical communications within Soviet Divisions handled over wire lines with teletype being used from Division up. At all times, Soviet doctrine dictates that maximum utilization be made of existing civil facilities. In addition, should the radio circuits be effectively reversion of radio traffic to the new micro-wave relay systems being installed and to other equipment above 30 mc/s will be initiated.

The Orbit countries, in line with Soviet policy, will revert to other means of communications popular to the Soviet Army, such as visual signals including such items as pyrotechnics, heliograph, semaphore and panels, which are normally used for the transmission of simple commands and target designations.

Messengers are a basic and important means of communicatio in the Soviet Army and are used at all echelons of all arms; however, the command lisison officer, a specially trained and responsible staff officer, presents the most unusual means of tactical communication. As a result of his special training, the command lisison officer is able to react at any time to any given situation in the same manner as his commander. Consequently, the use of command liaison officers also tends to reduce the requirement for conventional means of communications.

In event of electromagnetic retaliation against the Soviet Orbit it appears certain that all communication facilities within the Orbit would be taken over immediately by the military. This would increase the military capacity and provide certain alternate communicatio circuits. It is probable that increased reliance would be placed upon landlines and micro-wave links where available. The imposition of more stringent traffic priority classifications could be expected. It is believed that resort to airmail would follow, particularly in Eastern USSR where radio now forms the backbone of communications. Reports of an intensified program of carrier pigeon training by Soviet military forces is indicative of the probable use of this form of communication in the event normal communication channels are denied.

Electromagnetic countermeasures directed toward air navigational aids probably would be quite effective since the Soviet Air Force is not known to have readily available a substitute system immune to such measures.

If the western nations were to retaliate in an electromagnetic war, it is believed the efficiency of Orbit telecommunications could be seriously impaired.

Diversion of Resources.

Retaliation, if effective, would be expected to induce some diversion of resources. The nature and magnitude of diversion would seem to be a function of the extent to which the Kremlin failed correctly to measure the nature and extent of retaliation effectiveness in fact. Assessment of such diversion is difficult if not impossible. The level of diversion would appear to hinge upon the essentiality of the class of channels(Section III) dependent upon the radio medium which was effectively jammed. The diversion of resources for command channels could be considerable. This could involve special aircraft courier service, hurried construction of new wire and micro-wave radio facilities involving large numbers of construction manpower, reassignment of critical raw materials and equipment from other uses, and possibly the construction of new access roads for vehicular service. These diversions would likely take place for intelligence, operational, and support channels using the radio medium but to a lessened degree respectively.

IV. An Estimate of Soviet Orbit Cold War Electromagnetic Warfare Intentions

Intention may be assessed by analyses of performance, implications, and planning.

As to performance, the Soviet Orbit has been building what appears to be a jamming system. The magnitude and effectiveness of the system appears to be increasing. By performance the system is directed principally if not wholly against "hostile" radio signals entering the "sovereign" domain of the Orbit. It is meeting with appreciable technical success, but questionable psychological and communication success. Some signals get through. Forbidden fruit is sweet. Word of mouth is also a form of mass communication. Openly the Kremlin defends its action on the legalistic grounds that the transmission of "hostile", unwanted, anti-state signals into a foreign land is a breach of sovereign rights. The open objective of this jamming then is the prevention of reception in the Orbit of foreign "bourgeois propaganda." This objective is consistent with established discontinuities in all forms of East-West communication. Thus far the effort at establishing a radio discontinuity has been applied almost exclusively to the mass aural radiobroadcasting service.

It would, however, be hazardous to our communication security to conclude that this open objective represents total Soviet intention. There is evidence to suggest that this open objective may not be the only objective or even the principal objective of the current jamming effort. Similar, if not better, results could seemingly be obtained by confiscation of receivers capable of foreign reception. This apparently has not been done on a wide scale, though it is well within the police powers of the Kremlin. Reasons for not taking this effective, though perhaps psychologically drastic, action are not known.

Steps short of this action have been taken, however. Foreign listening is "discouraged" in numerous ways. Security of listening is promoted by the encouragement of group listening. Production of radio tube receivers for private sale is curtailed. Prices are high. Production of cheap, insensitive crystal receivers has been increasing. Construction of wire diffusion centers serving loudspeakers continues at a high rate. The centers, being under state control and supervision, send out only sanitized programs. In terms of the number of transmitters employed, the Orbit mass aural radio transmission base appears inadequate to serve so large an area through the radio medium alone.

These intermediate--in time more than in effect--measures of actual performance offer material over which to speculate on implied intentions. The jamming performance today may have a dual purpose. It helps to achieve more complete East-West communication discontinuity. And it serves a a proving and exercising ground for the development of a broader electromagnetic warfare resource. But if the intermediate measures are developed to their ultimate end, the foreign radiobroadcast reception base in the Orbit will have been eradicated, and with it the need for jamming foreign radiobroadcasts. This would leave the Orbit with a jamming resource without a mission. What is to become of it?

It would be extraordinary indeed, if these implications have any basis in fact, to surmise that the Kremlin planning for jamming were limited in scope to considerations of foreign radiobroadcast service alone. It must occur to the Kremlin that its antagonists are polarized on the United States, that the United States is removed in distance, hence time, from its European and Pacific allies, and that, in consequence of the latter, the sparsity of other rapid media and the length or inadequacies of rapid physical media, the United States is heavy dependent upon radio for rapid communications with its allies and its own strategic bases.

It is not believed the Soviets will fully reveal their potential for Electromagnetic Warfare during a cold-war period. A full effort of jamming during the cold-war period against military circuits is not contemplated.

The Soviets will probably attempt to minimize their vulnerability by frequency flexibility, by providing ease of transmitter tuning, use of antennas as directive as possible, judicious use of frequencies in relation to propagation conditions, use of more selective receivers, use of short trans mission techniques (flash), greater use of frequencies above 30 megacycles for tactical services, continued increase in activity at the very low frequencies, probable use of frequencies in the 10-15 kilocycles band from shore points which will provide them temporary immunity from countermeasures, and other well-established means of improving traffic speed, decreasing time on the air, and reducing over-all traffic and chatter.

A. As to Minimization of Electromagnetic Warfare Vulnerabilities

Vulnerability has been defined here as the susceptibility of the Soviet Orbit to disruption in the exercise of the sum total activities of the state in all its ramifications. The key to assessment of vulnerability is the measurement of the strategic essentiality of Orbit radio services for those purposes. It is thought that the Orbit can considerably minimize further its cold war vulnerabilities. This can be done by reducing its present heavy dependence on the radio medium below 30,000 kilocycles. It possesses the productive and manpower capabilities to do so. Construction of wire lines and/or microwave radio systems to round out its basic and non-mobile rapid communications facilities in large portions of the domain east of the Urals, increases in non-rapid media capacities in thin areas scattered around the Orbit, and improvements and extensions of rapid physical media would markedly reduce the strategic essentiality of Orbit radio services.

But it can not completely overcome this strategic essentiality without impairment of strategic power. Radio is needed for long-range mobile operations, principally for its air, sea, and land power. The Kremlin is unlikely to ignore this insurmountable condition in contriving to decide on the initiation of enlarged electromagnetic warfare.

It seems quite clear that, under cold war conditions, the Kremlin intends to continue to work toward minimization of the strategic essentiality of Orbit radio services. But this will probably not be done at the risk of incurring serious disturbance to rapid and full flowering of Orbit strategic power.

B. As to Maximization of Cold War Electromagnetic Warfare

There is no evidence at hand to indicate that the Kremlin has, in fact, invoked thus far in the post World War II period any of its electromagnetic warfare capabilities for what have been popularly called cold wars (Berlin Blockade, Korea, Indo-China). The current jamming effort against foreign radiobroadcasting, per se, can be characterized as a legal contest with psychological warfare implications. But this is not to say that in any contrived future cold war incited by the Kremlin but executed by second parties the Kremlin would not invoke some degree of electromagnetic warfare of the real variety. It would likely be innocently localized so as not to reveal the Kremlin's full hand of tricks. These would be reserve in the interest of surprise and of catching the major enemies unprepared for a hot war in which the Kremlin would assumably hold the combat and electromagnetic warfare initiative.

V. Conclusions

The Soviet Orbit possesses, in being, a mammoth rapid communications resource, included in which are active jamming facilities. The Orbit holds the power to and probably is improving and expanding this communications resource. It contains inadequacies in scope and depth. These are being overcome, but more than two years will be required to minimize them. In the meantime its vulnerability in terms of the strategic essentiality of its radio services is high. At the same time, it possesses a huge untapped electromagnetic warfare capability. But the full commitment of this capability in the face of its high vulnerability would be intolerable for several years to come. The Kremlin may tap this capability in part and only under localized cold war conditions in such wise as not to provoke broad retaliation on the part of free nation members of the United Nations. To do otherwise would simply warn the West of the shape of things to come and thus afford reason and opportunity for the development of retaliatory capability (unless that capability already exists. This tip-off would destroy the element of surprise which the Kremlin may wish to preserve. The problem is of sufficient magnitude and importance to justify continuing study and positive action.

Postcript: Effects of a Hot War upon the Conclusions Reached in (V) for a Cold War.

A. Civil

Three assumptions are made here: 1) That the hot war enemy is polarized at the United States; 2) That the Soviet Orbit possesses greater electromagnetic warfare capability than do the free nations of the United Nations (This is pure conjecture); and 3) That the Kremlin is aware of (2). The incidence of a hot war would invoke on the part of the Soviet Orbit as full an employment of its electromagnetic warfare capability as its war time legimate strategic essential radio needs would permit.